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1. INTRODUCTION

- 1.1.1 British Waterways and the Grantham Canal Partnership propose to restore the Grantham Canal to navigation. The proposals will require large-scale dredging of the canal to navigable depth and localised engineering works to canalside structures such as locks and bridges. These works will result in disturbance to aquatic habitats, communities and species throughout the canal and more localised disturbance to terrestrial habitats in the vicinity of engineering works.
- 1.1.2 The Grantham Canal supports diverse assemblages of animal and plant species and represents an important nature conservation resource. The value of the habitats and species interests present within the canal corridor is recognised in the designation of the Harby to Redmile section as a Site of Special Scientific Interest (SSSI).
- 1.1.3 To ensure that the restoration proposals do not harm the ecological interests of the canal corridor, and that the opportunity is taken wherever possible to enhance the value of the canal corridor for nature conservation as part of the proposed restoration, the Grantham Canal Partnership have commissioned ECUS Ltd to undertake ecological survey of the canal corridor; to consider the risks and opportunities associated with a variety of potential restoration options for the canal; to assess the likely impacts of the proposed restoration on the ecological interest features of the canal, and to suggest appropriate methods to avoid, compensate or mitigate any potential impacts as appropriate. The detailed findings of ecological survey have been produced as a stand-alone survey report.
- 1.1.4 This report details the following:
- data consultation with statutory and non-statutory nature conservation organisations;
 - habitat and species surveys and descriptions of baseline conditions;
 - evaluation of the ecological interest of the site;
 - consideration of alternative restoration scenarios
 - assessment of the potential ecological impacts associated with the proposed development, and
 - mitigation proposals as appropriate.
- 1.1.5 The information gathered from data consultation and from the findings of surveys commissioned as part of this work have been used to form the evaluation of ecological features and assess potential impacts.
- 1.1.6 The assessment has been carried out based on the Institute of Ecology and Environmental Management 'Guidelines For Ecological Impact Assessment'.

2. Methodology

- 2.1.1 In order to identify and evaluate the ecological interests of the Grantham Canal, the following works have been undertaken.

2.2 Desk Study and Data Consultation

- 2.2.1 A programme of desk study and data consultation was undertaken immediately following award of contract and includes consideration of all known biological records within 1 km of the canal corridor. This included particular consideration of biological records compiled by British Waterways and supplied to ECUS as part of the contract, along with data from other sources including prior knowledge of the canal by the project team. The MAGIC website (www.magic.gov.uk) was consulted to identify any statutory protected sites within 1 km of the route.
- 2.2.2 Records supplied by consultees were used to target key areas for species surveys, in particular water vole and badger.

2.3 Walkthrough/Extended Phase I Survey

- 2.3.1 Walkthrough survey was undertaken in August and early September 2006 to ensure completion of botanical and species surveys within their optimal survey periods, as required by the methodologies applied.
- 2.3.2 Walkthrough survey of the canal corridor was undertaken based on the standard extended Phase I habitat survey methodology (JNCC 1990), and identified ecological interest features associated with the canal corridor. Habitats were mapped at an appropriate scale and note was made of any features or species of particular interest.
- 2.3.3 Recording of aquatic and marginal vegetation was undertaken based on the 'extensive length' canal survey methodology developed by Eaton and Wilby (2002). The canal was divided into 0.5 - 1 km sections, delineated by key features such as bridges and locks. Sections were steadily walked and records made of emergent, floating-leaved and submerged plant species with DAFOR abundance ratings assigned for each species within each section as a whole. Physical characteristics were recorded including bank type, shading, water clarity/colour, key features including feeders, moorings and recent management works.
- 2.3.4 DAFOR is a subjective abundance rating classification system, designed to aid rapid description of species abundance while yielding statistically useful data. Classification following this method is not intended to provide a complete list of species for any given habitat. The standardised terms of the DAFOR system are as follows:
- D Dominant
 - A Abundant
 - F Frequent
 - O Occasional
 - R Rare

- 2.3.5 Submerged vegetation was recorded by taking grapnel samples at regular intervals (100 m approx), with additional sampling being undertaken where areas of submerged vegetation were apparent from the bank. Where appropriate, more intensive grapnel searches were made over a 20 m length of channel approximately halfway along each section in a representative section of channel. Five samples were taken and all emergent and floating vegetation recorded.
- 2.3.6 In addition to mapping the species and habitats present, results of walkthrough survey were recorded on a section-by-section basis on field recording sheets.

2.4 Phase II surveys

- 2.4.1 The intention of Phase II surveys was to identify all potential ecological receptors that will require consideration during the ecological assessment process and ensure that sufficient information is gathered to enable suitably robust assessment to be undertaken.
- 2.4.2 Phase II surveys undertaken comprised surveys for the following species and groups:
- aquatic macrophytes and emergent vegetation;
 - invertebrates;
 - otter and water vole;
 - bats, and
 - badger.

Aquatic macrophytes and marginal/emergent communities.

- 2.4.3 To ensure that aquatic macrophyte communities were recorded in sufficient detail to enable robust evaluation and subsequent assessment of these communities, the 'extensive' survey method was supplemented in areas identified as supporting aquatic macrophyte communities of nature conservation importance using the 'intensive' survey methodology for assessment of canal SSSI (Wilby and Eaton, 2002). Intensive surveys were undertaken between Harby and Woolsthorpe at 3-4 km intervals.

Invertebrates

- 2.4.4 Baseline terrestrial and aquatic macroinvertebrate survey was undertaken within the Harby – Redmile SSSI. As this was considered at the tender stage to represent the most pragmatic balance between cost effectiveness and recording of communities likely to be of value. Diverse aquatic invertebrate communities are mentioned on the citation for the Harby – Redmile SSSI, this section of canal was selected for this reason.
- 2.4.5 For terrestrial invertebrates this comprised an assessment of the value of key terrestrial habitats along the canal corridor integrated with searches of existing records to identify likely entomological interests. In view of the timescales of the contract no detailed sampling for terrestrial invertebrates

was undertaken, but searches of key habitats were made as part of the invertebrate habitat assessment.

- 2.4.6 For aquatic macroinvertebrates sampling was undertaken at key locations throughout the SSSI and was supplemented with additional sampling of the canal and adjacent wetland habitats outwith the SSSI boundary.
- 2.4.7 Sites were selected to reflect water quality features such as inflows and the range of habitats present in the canal. At each site representative samples were obtained through proportional sampling of habitats. Survey was undertaken using standard EA methodologies appropriate to the local conditions, based on 3-minute kick-sampling and/or hand net-sweeping.
- 2.4.8 Both terrestrial and aquatic invertebrate samples were identified to species level where possible. The samples were inspected in the field and notable species recorded before the samples were preserved and retained for identification in ECUS laboratories. This included identification of any European and UK protected species, Red Data Book species, national Biodiversity Action Plan species (BAP) and local BAP species. Organisms for which no key exists or that are too small were not identified to species level. Identification of invertebrate taxa was undertaken by suitably qualified and experienced taxonomists. Voucher specimens were accurately recorded, preserved and stored and can be made available on request.

Water vole

- 2.4.9 Water vole survey of the canal banks was undertaken following the methodology detailed in the water-vole conservation handbook (Strachan, 1998), where historic records existed or signs of possible water vole activity were identified during the Phase I survey.

Otter

- 2.4.10 As otter activity has previously been recorded from the Grantham Canal, survey of potential habitat (identified during the Phase I survey) was carried out following the National Otter Survey methodology (Strachan and Jefferies, 1996). This was typically around features connecting the canal to the wider catchment such as rivers and other watercourses.

Amphibians

- 2.4.11 An assessment of the potential of the canal and adjacent wetland habitats to support amphibians, in particular great-crested newt was undertaken as part of the Phase I survey. This included egg and larval searches of potentially suitable waterbodies.

Bat Survey

- 2.4.12 The potential for features such as cracks and crevices associated with trees and structures (e.g. bridges and culverts) along the canal corridor to support roosting bats was assessed utilising close-focusing binoculars to inspect structures and vegetation for potential roosting areas.

2.4.13 An initial appraisal of trees and structures along the entire route was undertaken as part of the Phase I survey to identify whether features likely to be of interest to roosting bats were present.

2.4.14 Where trees or structures found to contain features of some potential interest to roosting bats were identified, these were subject to more detailed bat roost potential survey. Each feature was assigned to a defined category of roosting potential as follows:

- **Negligible:** a feature that appears initially to have significant bat roost potential, but is considered on closer inspection to have negligible potential to support roosting bats.
- **Low:** a feature that may have some superficial interest to roosting bats, but is considered suboptimal to the extent that bats are not considered likely to use the feature for shelter.
- **Moderate:** a feature that has some potential to support roosting bats, but is considered to be less than ideal in some way.
- **High:** This category is used to describe an optimal feature considered to be ideally suitable for use by roosting bats where no evidence of occupation by bats has been found.
- **Confirmed:** positive evidence of bats usage has been recorded from a feature.

2.4.15 Where features considered to have high potential to support roosting bats were identified, or bat usage of a feature was confirmed, bat survey was supplemented with evening emergence surveys utilising electronic bat detectors to enable identification of any bat species present. The surrounding habitats were also recorded and evaluated for their suitability as foraging habitat for bats. The evening survey was carried out on Wednesday 11th October 2006 using Pettersson D100 and D230 bat detectors and a Wolf-3 Supergen 2 night vision scope with additional 120 l.e.d. 12v. infra red illumination. The evening was overcast with initial occasional light rain.

Badger Survey

2.4.16 Badger survey of the canal was undertaken following methods detailed in Surveying Badgers (Harris, Cresswell and Jefferies, 1989). This included survey for badger setts including assessment of sett size and status along with survey of linear features and boundaries for signs of badger activity including dung pits, scrapes, feeding signs and pathways.

Birds

2.4.17 The opportunity was taken during walkthrough survey to record bird species along the entire canal, and particularly within the SSSI. Note was made of any protected, rare or notable species in addition to areas of key habitat for breeding and foraging birds.

2.5 Ecological Assessment Methodology

2.5.1 The value and sensitivity of ecological features was determined based on the guidance given in 'Guidelines on Ecological Impact Assessment' (IEM, consultation draft, July 2005). Individual ecological receptors (habitats and

species that could be affected by the development) were assigned levels of importance for nature conservation in one of the following categories:

- International
- UK
- National
- County
- District
- Local, or
- Within the immediate zone of influence only.

2.5.2 For a given receptor determination of value includes consideration of the size, conservation status and quality of the species or feature.

Valuation of Habitats

2.5.3 Some sites are automatically assigned a nature conservation value through designation and the reason for designation is taken into account in EclA. Designated sites are considered at the following levels:

- International – Special Areas of Conservation (SAC), Special Protected Areas (SPA) and RAMSAR Sites. World Heritage Sites also are considered to be of international value at the site level, but not necessarily in terms of their ecological value.
- National – Sites of Special Scientific Interest (SSSI) in England, Scotland or Wales and Areas of Special Scientific Interest (ASSI) in Northern Ireland
- County or District – sites designated by Local Authorities or County Wildlife Trusts and others

2.5.4 Habitats that are not subject to specific nature conservation designations have been valued against published selection criteria where possible, including the following:

- Habitats Directive, 1992
- Guidelines for the selection of biological SSSI

2.5.5 In determining values of habitats consideration has also been given to national and local Habitat Action Plans and the appropriate ancient woodland inventory in conjunction with critical appraisal of the size, status and quality of the habitat affected.

Species

2.5.6 In ascribing values to populations of species consideration has been given to the legal status of species, as well as their size and status on the site and within the geographic area. Certain species receive protection under various pieces of legislation and this has been taken into account when determining value. Legislation considered includes:

- The Habitats Directive, 1992;
- The Conservation (Natural Habitats &c.) Regulations 1994;
- The Wildlife and Countryside Act, 1981 (as amended), and
- The Countryside and Rights of Way Act, 2000 (CROW).

- 2.5.7 The rarity of the species in the context of status, i.e. whether populations of a species are declining either nationally or at a more local level has also been considered.
- 2.5.8 The presence of invasive alien species or injurious weeds is considered to represent an ecological disbenefit.

Sources and magnitude of impact

- 2.5.9 The key sources of impact to the nature conservation interests of the area resulting from the development may arise as direct and indirect effects, examples of which are given below:

Direct effects:

- Habitat loss (landtake), where the severity of impact is directly related to the amount of habitat lost and the conservation value of that habitat.
- Habitat fragmentation (severance of habitats and/or wildlife corridors linking them). This can lead to reduced genetic diversity and increase the likelihood of species being lost.

Indirect effects:

- Including disturbance (visual, noise or vibration), dust deposition, incidental vehicle trafficking, water discharges and surface runoff. These impacts may affect habitats both within and outside the footprint of the works.

2.5.10 Impacts may also be either temporary or permanent in nature. Temporary effects occur during the construction phase of development and may include impacts such as short-term increases in dust deposition resulting from construction traffic. It should be appreciated that temporary loss of habitats of high value for nature conservation may have as great or greater impact as permanent landtake of less sensitive habitats.

2.5.11 Landtake associated with the proposed development is considered to be permanent and some indirect effects may also be permanent.

2.5.12 The magnitudes of impacts are evaluated in terms of their predicted effect on the integrity of an ecological receptor, where integrity is defined as 'the coherence of ecological structure and function that enables the feature to be maintained in its present condition'. Consideration is given to the nature and duration of the disturbance, its reversibility, timing and frequency as well as any cumulative effects. and the potential for impact avoidance or minimisation.

2.5.13 In assessing the significance of impacts each impact has been considered in its entirety, ensuring all identified facets of the impact are considered. The significance of an impact depends upon the nature of the impact, the magnitude and duration of the impact and the sensitivity or importance of the receptors that it affects. For the purpose of this assessment the significance of all potential impacts to habitats of local or higher conservation value has been undertaken.

2.5.14 A significant impact is defined as an impact (adverse or positive) on the integrity of a defined site or ecosystem, and/or the conservation status of habitats or species within a geographical area, including cumulative impacts. The value of the significantly affected receptor is then used to determine the implications, in terms of legislation, policy and/or development control.

2.5.15 If an impact is found not to be significant at the highest geographical level at which the receptor has been valued it may be significant at a lower geographical level. Significant impacts on ecological receptors have been determined in accordance with guidance derived from policies applied at a scale relevant to the value of the feature or resource. Any significant impacts remaining after mitigation are termed residual impacts and should be

considered in the context of legislation, policy and development control in determining the application.

- 2.5.16 It is also useful to assign a level of confidence to the assessment of individual impacts and the definitions for confidence levels are shown in Table 1. Unless otherwise stated confidence levels are high.

Table 1: Confidence levels

Confidence level	Criteria
High	The predicted impact is either certain e.g. landtake or is considered to be very likely to occur based on reliable information and/or previous experience
Low	The predicted impact and its level are best guesses generally derived from first principles of ecological theory and the experience of the assessor. More information may be required to improve the level of confidence

2.6 Limitations

- 2.6.1 Due to the seasonal constraints of the project it was not possible to undertake a full suite of surveys for some species and species groups, notably amphibians, breeding birds and terrestrial invertebrates. The efficiency of bat survey may have been improved had survey been undertaken in early summer before any maternity roosts that may have been present had dispersed. Access to the banks for water vole survey was restricted by limited access to the offside, and dense marginal and emergent vegetation fringes in some areas. Undertaking additional water vole survey in early spring prior to vegetation becoming established would increase the confidence level of survey.
- 2.6.2 Where it is considered that limitations have affected the robustness of the evaluation and therefore the robustness of the assessment this is reflected by the confidence levels of the prescribed as detailed in Table 1 above.

3. Baseline Conditions

- 3.1.1 The features of nature conservation importance that may be affected by the proposed restoration are described and evaluated below and summarised in Table 2 at the end of the section. Raw data obtained from surveys are included within the survey report.

3.2 Designated Sites

- 3.2.1 Three statutory designated sites and several non-statutory designated sites are present within or adjacent to the canal corridor. The nature conservation interests of individual sites are detailed below. The locations of all sites of nature conservation importance are shown on Figure 1.

Grantham Canal: Harby to Redmile SSSI

- 3.2.2 The Grantham Canal Harby – Redmile SSSI comprises a 12.69 ha of the Grantham Canal and its banks, equating to approximately 6.6 km of the canal corridor. The site was designated in 1981, when it included some of the best areas of open water and associated marginal habitats in Leicestershire. The citation makes particular note of the bankside and emergent vegetation communities present within the canal corridor, with species noted on the citation including fleabane (*Pulicaria dysenterica*), skullcap (*Scutellaria galericulata*), gipsywort (*Lycopus europaeus*), lesser water parsnip (*Berula erecta*), branched bur-reed (*Sparganium erectum*), flowering rush (*Butomus umbellatus*) and water horsetail (*Equisetum fluviatile*). A limited number of aquatic macrophyte species noted on the citation including broad-leaved pondweed (*Potamogeton natans*), rigid hornwort (*Ceratophyllum demersum*) and Canadian waterweed (*Elodea canadensis*), although the canal supports a more diverse macrophyte assemblage than indicated, with the nationally scarce pondweed species grasswack pondweed (*Potamogeton compressus*) having previously been recorded within the SSSI section of the Grantham Canal. The citation also notes that the SSSI supports diverse assemblages of aquatic and terrestrial invertebrates.
- 3.2.3 The SSSI comprises seven Units, all of which were recorded as being in 'unfavourable, declining' condition at the time of the latest assessment (July 2000). The findings of condition assessment are supported by the findings of 2006 survey, which recorded the aquatic macrophyte communities of the Harby-Redmile SSSI to be overwhelmingly dominated by rigid hornwort with common duckweed (*Lemna minor*). The only other submerged or floating aquatic macrophyte species recorded within the SSSI section were white waterlily (*Nymphaea alba*), which was recorded as two discrete patches from around Stathern bridge, frogbit (*Hydrocharis morsus ranae*), which was recorded from a single location adjacent to the dismantled railway crossing near Warren Farm and fennel pondweed (*Potamogeton pectinatus*), which was recorded at very low abundance to the north of Stathern Bridge.
- 3.2.4 Marginal and emergent vegetation present within the SSSI is more diverse and extensive sections of channel are completely dominated by emergent vegetation, with up to 100 % cover of the channel by bulrush (*Typha latifolia*), common reed (*Phragmites australis*) and water soldier (*Stratiotes aloides*) in different areas. Branched bur-reed and reed sweet-grass form abundant components of the marginal fringe along the majority of the SSSI section, with lesser water parsnip being locally abundant in the channel margins.

Flowering rush, water mint (*Mentha aquatica*), gipsywort, water plantain (*Alisma plantago-aquatica*) and arrowhead (*Sagittaria sagittifolia*) were all recorded occasionally within the SSSI.

- 3.2.5 Harby to Redmile SSSI is of national importance for nature conservation. The nature conservation condition of the Harby to Redmile_SSSI is currently assessed as unfavourable.

Muston Meadows SSSI/NNR

- 3.2.6 Muston Meadows SSSI comprises 8.77 ha of neutral grassland located adjacent to Survey Section 29 of the Grantham Canal. The SSSI comprises three units, all of which were recorded as being in favourable condition at the time of the latest assessment (July 2005).
- 3.2.7 The National Nature Reserve comprises 41 ha of lowland meadow, including the SSSI and supports a diverse assemblage of grasses and flowering plants including over 10,000 green-winged orchids. Ponds within the NNR support populations of the protected amphibian species great-crested newt.
- 3.2.8 Neither the SSSI or NNR include the Grantham Canal within their boundaries, but the NNR is located immediately adjacent to the canal along much of its southern boundary, and the SSSI lies within 20 m of the canal towpath at its closest point.
- 3.2.9 In view of their nationally protected status, Muston Meadows SSSI and NNR are considered to be of national importance for nature conservation.

Kinoulton Marsh and Canal SSSI

- 3.2.10 Kinoulton Marsh and Canal SSSI comprises 2.94 ha of marsh and neutral grassland, incorporating a 290 m section of the Grantham Canal (within Survey Section 12) as its northern boundary. The site was designated in 1981, when it was cited as including some of the richest marsh and open water habitats in Nottinghamshire, and was considered representative of wetland plant communities on relatively base-rich soils in central and eastern England. The SSSI is made up of two units comprising Unit 1, an area of lowland neutral grassland and Unit 2, the Canal and an adjacent pond. At the time of most recent condition assessment Unit 1 (July 2005) was recorded as being in 'unfavourable recovering' condition and Unit 2 (the canal, August 2003) was recorded as 'unfavourable, no change'.
- 3.2.11 Survey of this section undertaken as part of this assessment process recorded the macrophyte communities within the SSSI as comprising common duckweed (*Lemna minor*) and rigid hornwort (*Ceratophyllum demersum*), both of which were locally dominant, with limited open water being present. Three pondweed species comprising broad-leaved pondweed (*Potamogeton natans*), lesser pondweed (*Potamogeton pusillus*) and curled pondweed (*Potamogeton crispus*), are included on the citation for the site, but none of these species were present in 2006. Rigid hornwort is noted as being present on the citation and it seems likely that this species has outcompeted less vigorous species including pondweeds since the time of designation.
- 3.2.12 Kinoulton Marsh and Canal SSSI is considered to be of national importance for nature conservation

- 3.2.13 In addition to these nationally designated sites, a number of sites are present adjacent to the canal, which are designated for their importance for nature conservation at a district or county level. These sites are typically designated at a county level and include the following sites for each county:

Nottinghamshire

- 3.2.14 **Grantham Canal and Lock Pound SINC** (NGR SK584385 to SK598375): This section of the Grantham Canal is designated as a Site of Importance for Nature Conservation (SINC) by Nottinghamshire Geological and Biological Record Centre for its vegetation communities including common reed, branched bur-reed and marsh woundwort (*Stachys palustris*).
- 3.2.15 **Gamston Marsh SINC** (NGR SK602368): Small marsh next to the canal with jointed rush (*Juncus articulatus*), water plantain (*Alisma plantago-aquatica*) and floating sweet-grass (*Glyceria fluitans*).
- 3.2.16 **Hollygate Bridge Grassland SINC** (NGR SK653358): Two species rich ridge and furrow grasslands adjacent to the canal.
- 3.2.17 **Hollygate Bridge to Kinoulton SINC** (NGR SK654357 to SK676306): A length of canal with a mix of aquatic, marsh and dry grassland communities.
- 3.2.18 **Hoehill Pasture SINC** (NGR SK680359): Ridge and furrow pasture with a herb rich sward lightly grazed by cattle.
- 3.2.19 **Kinoulton Grasslands SINC** (NGR SK673308): Two fields of ridge and furrow pasture.
- 3.2.20 **Canal from Kinoulton to the River Smite SINC** (NGR SK676306 to SK715294): Designated for its diverse marginal vegetation.
- 3.2.21 **Kinoulton Grasslands SINC** (NGR SK675304): An area of species rich ridge and furrow grasslands.
- 3.2.22 **Old Stone Pit SINC** (NGR SK670316): Disused quarry with exposed fossiliferous limestones and shales from the Lower Lias.

Lincolnshire

- 3.2.23 **Grantham Canal and Grantham Canal Bank SNCI**: The entirety of the canal and its banks within Lincolnshire is designated as a Site of Nature Conservation Importance (SNCI) by Lincolnshire Wildlife Trust. This level of designation is considered to be of county importance for nature conservation.
- 3.2.24 **Denton Reservoir SNCI** (NGR SK870337): This site was originally surrounded by rich marsh and marginal communities. The botanical diversity of the reservoir may have been compromised by fishing and associated unofficial vegetation clearance. The site is also reported as supporting a diverse bird assemblage with BAP species including kingfisher (*Alcedo atthis*) lapwing (*Vanellus vanellus*) and green woodpecker (*Picus viridis*) having been recorded.
- 3.2.25 **Field by Denton Reservoir SNCI**. No information available

- 3.2.26 **Cliff Wood SNCI** (NGR SK 843 345): Replanted ancient woodland with a diverse field layer including male fern (*Dryopteris felix-mas*), herb robert (*Geranium robertianum*) and enchanters nightshade (*Circaea lutetiana*)

Leicestershire

- 3.2.27 **Grantham Canal LWS**: The whole of the canal in Leicestershire is designated as a Local Wildlife Site (LWS) of either county, district or parish importance by the Leicestershire Ecology Unit. The level of designation is a reflection of the relative value of the mosaic of habitats and communities present
- 3.2.28 **Berry Hill Pond LWS** (NGR SK675367): A field pond supporting rich communities of aquatic and marginal plants.
- 3.2.29 **Knipton Reservoir LWS** (NGR SK817 305): Reservoir and associated habitats considered of conservation interest for its marsh, scrub, trees and pastures.

3.3 Habitats

- 3.3.1 The Grantham Canal is a contour canal, largely following the topography of the surrounding landscape and is characterised by long pounds flowing broadly east to west through gently rolling, low-lying agricultural land. The surrounding landuse is predominantly arable with some improved and semi-improved pasture fields.
- 3.3.2 The aquatic, marginal/emergent and bankside and terrestrial vegetation communities of the Grantham Canal are briefly described below. A summary of vegetation species recorded in individual sections of the Grantham canal is given in Appendix 1.

Aquatic vegetation

- 3.3.3 The aquatic macrophyte communities of the Grantham Canal are characteristic of lowland canal communities, being dominated by species typically of still or slow-flowing nutrient-rich waters. Rigid hornwort dominates extensive sections of the canal, sometimes occurring with American and/or Nuttall's waterweed (*Elodea* spp.). Common duckweed (*Lemna minor*) also dominates in some stretches, often with frequently occurring fat duckweed (*Lemna gibba*).
- 3.3.4 Areas supporting more diverse aquatic vegetation communities exist locally, with such communities typically occurring between Redmile and Woolsthorpe, to the west of the SSSI. Species present include fan-leaved water-crowfoot (*Ranunculus circinatus*), which occurs between Muston Gorse and Muston Bridge, and various pondweed species including broad-leaved pondweed (*Potamogeton natans*), fennel pondweed (*Potamogeton pectinatus*), and perfoliate pondweed (*Potamogeton perfoliatus*) and curled pondweed (*Potamogeton crispus*). Common water starwort (*Callitriche stagnalis*) dominates the aquatic vegetation in the shaded section towards the eastern limit of the canal in Grantham
- 3.3.5 The rare aquatic plant grass-wrack pondweed (*Potamogeton compressus*) is present to the east of the SSSI between Redmile and Muston Bridge

(Sections 28 to 30). This species is scattered throughout this length and is locally frequent to locally abundant in some areas. Grasswrack pondweed is included as priority species on the UKBAP and is in decline in Britain, and throughout its natural range. Formerly a species typical of mesotrophic to eutrophic riparian features such as oxbows and backwaters, the majority of river populations of grasswrack pondweed have been lost as a result of environmental change in the form of riparian engineering, channelisation and hypereutrophication. As a result, the majority of UK populations of this species are now restricted to a small number of locations within the UK canal system. In view of the current importance of canals in maintaining this species in Britain, British Waterways are identified as the lead partner for grasswrack pondweed conservation in the UKBAP. The Grantham Canal represents an important reservoir population of this species in the UK. In view of the restricted distribution of grasswrack pondweed, and its ongoing decline in Britain, populations of this species in the Grantham Canal are considered to be of national importance for nature conservation.

- 3.3.6 Two non-native invasive macrophyte species were recorded during survey, comprising water hyacinth (*Eichhornia crassipes*) and water fern (*Azolla filiculoides*). Water hyacinth was recorded between Longmoor and Denton Bridges, where it scattered over the length of the section in relatively small amounts. Water fern was present occasionally between Woolsthorpe Bridge and Woolsthorpe Wharfe (Section 31). The presence of these species is considered to represent an ecological disbenefit to the canal corridor.

Marginal and emergent vegetation

- 3.3.7 The Grantham Canal supports diverse assemblages of marginal and emergent vegetation communities. Emergent vegetation fringes are present throughout much of the length of the canal and are typified by locally dominant reed sweet-grass (*Glyceria maxima*) and branched bur-reed (*Sparganium erectum*) with yellow iris (*Iris pseudacorus*) and flowering rush (*Butomus umbellatus*) occurring occasionally. Lesser water parsnip (*Berula erectum*) is a frequent and sometimes abundant component of the emergent fringes and bulrush (*Typha latifolia*) is also locally abundant. Common reed (*Phragmites australis*) dominates the marginal vegetation in some areas, where it is often present at up to 100% cover of the canal.
- 3.3.8 Other marginal and emergent species present either infrequently or at low abundance include watermint (*Mentha aquatica*), gypsywort (*Iris pseudocorus*), arrowhead (*Sagittaria sagittifolia*), water plantain (*Alisma plantago-aquatica*) and various sedge and rush species. The marginal and emergent vegetation communities of the Grantham Canal are considered to be of importance to nature conservation at a county level as they provide long sections of semi-continuous habitat. However, the botanical diversity of these habitat types varies considerably along the length of the canal
- 3.3.9 The marginal and emergent vegetation communities include sections of reedbed dominated by common reed. Common reed reedbed is included as a priority habitat on the UK BAP. Whilst the nature and quantity of reedbed present along the Grantham Canal is not sufficient for it to be considered to be nationally important, the presence of this habitat type is still considered to be important for nature conservation at a district level.

Terrestrial Habitats

- 3.3.10 Bankside and towpath vegetation is typically dominated by tall or mown grass and herb communities and ruderal vegetation. Species typically include coarse grasses such as perennial rye-grass (*Lolium perenne*), false oat-grass (*Arrhenatherum elatius*), Yorkshire fog (*Holcus lanatus*), cock's-foot (*Dactylis glomerata*) and common couch (*Elymus repens*), with common herb and ruderal species such as red clover (*Trifolium pratense*), white clover (*Trifolium repens*), white dead nettle (*Lamium alba*), creeping buttercup (*Ranunculus repens*) and meadow buttercup (*Ranunculus acris*). Some more diverse areas are present supporting species such as reed canary-grass (*Phalaris arundinacea*), meadowsweet (*Filipendula ulmaria*), hedge woundwort, (*Stachys sylvatica*), bittersweet (*Solanum dulcamara*), sedges (*Carex* spp.) and meadow vetchling (*Lathyrus pratensis*).
- 3.3.11 Species-poor hawthorn or blackthorn dominated hedgerows are present on the towpath side of the canal through most of its length. These are 1-2 m in height and are box-flailed and are largely intact with gap planting. Hedgerow trees dominated by ash (*Fraxinus excelsior*) are present in many of the hedgerows. The offside banks are typically dominated by grown-out hawthorn-dominated hedgerows and bankside trees including willow (*Salix* spp.), alder (*Alnus glutinosa*) and ash. Whilst the majority of hedgerows that line the canal corridor are of limited intrinsic nature conservation importance owing to their low species diversity, the hedgerow network as a whole is considered to be of district importance for nature conservation as it is largely intact and provides connectivity of terrestrial habitat along much of the length of the canal corridor.
- 3.3.12 The Cotgrave to Mackleys Farm section of the canal is currently out of water and comprises ruderal vegetation interspersed with wet and dry grassland and small water bodies. Whilst these habitats do not represent particularly diverse botanical communities they add structural diversity to the habitats present within the canal corridor and are likely to support a range of invertebrate, small mammal, amphibian and reptile species, including grass snake and possibly great-crested newt. The importance of such habitats for the individual species is considered in the sections below. These habitats are considered to be of intrinsic nature conservation importance at a local level.

3.4 Species

Water vole

- 3.4.1 The majority of the banks of the canal are broadly suitable for water vole, particularly on the offside, being dominated by soft, grassed earth banks with abundant marginal vegetation suitable for water vole foraging, which also provides cover for individual animals. Comprehensive survey for water vole is made difficult by limited access to the offside in many areas and dense emergent and/or bankside vegetation, which restricted visibility in many areas.
- 3.4.2 Historic records of water vole on the Grantham Canal exist predominantly from the western end of the canal, with records existing from all sections between the A52 road bridge and Hollygate Bridge. Whilst the habitat present in all these sections is suitable for water vole, no signs of water vole activity were recorded from the majority of these sections, although access to

the offside banks was often limited. Small mammal burrows and footprints were recorded from Section 5 near Hollygate Bridge and are thought to represent signs of water vole activity although no droppings or feeding signs were present.

- 3.4.3 Historic records of water vole also exist from Section 12, and the habitat here is suitable, although no signs were noted at the time of survey. Collapsed small mammal burrows were recorded from Section 25, where water vole have also been recorded previously, but no signs of active burrows was recorded, although visibility in this section was restricted by dense vegetation.
- 3.4.4 Signs of water vole activity, comprising burrows were recorded from Sections 29 to 31, between Muston Gorse and Stenwith Bridge. No previous records of water vole exist from these sections. No signs of recent activity such as latrines, feeding signs or footprints were recorded, but survey was limited by dense vegetation, which restricted visibility of some banks.
- 3.4.5 Water vole activity within the Grantham Canal corridor is relatively sparse, being characterised by low density populations scattered throughout the canal corridor. Whilst ample suitable habitat for water vole is available throughout the canal corridor signs of water vole activity were sparse and scattered with little apparent connectivity between populations. Where water vole are present the populations appear to be at low density, and the lack of evidence of recent activity means that the status of water vole remains unconfirmed. Mink have been recorded from the Grantham Canal and this species may be in the process of making this species extinct within the canal. The populations of water vole present on the Grantham canal are therefore considered to be of no more than district importance for nature conservation.

3.5 Grass snake

- 3.5.1 Whilst no specific reptile survey was undertaken, incidental records of grass snake were made from several sections of the Grantham Canal including from Section 1 adjacent to the A52 road bridge, the dry section and Section 30, to the east of Muston Bridge. The habitats throughout the canal are suitable for grass snake, and it is likely that this species is present throughout the length of the canal. As the canal corridor passes through a largely agricultural landscape it is likely that the Grantham Canal represents a key habitat for grass snake present in the area. The populations of grass snake on the Grantham Canal are therefore considered to be of district importance for nature conservation.

3.6 Badger

- 3.6.1 Five badger setts were recorded from the Grantham Canal during survey. These comprising a single hole sett in Section 1, which was located on the offside bank near to the A52 road bridge; single hole setts in Sections 7 and 17, and a six hole sett in Section 9. A further confirmed sett is present in Section 36, with a possible sett in Section 37.
- 3.6.2 Badger tracks were recorded sporadically throughout the canal, and latrines were also recorded, indicating that badger activity is widespread along the canal corridor. The canal corridor is likely to represent a resource of district importance to nature conservation in respect of its value for residential and foraging badger.

3.7 Bats

3.7.1 The majority of bridges on the Grantham Canal are not particularly suitable for roosting bats as they typically comprise concrete piped culverts of around 0.6 m diameter.

3.7.2 A number of trees with potential to support roosting bats were identified during walkover survey and these were subject to more detailed assessment and evening emergence survey. A small number of canalside buildings also have some potential to support roosting bats, and further survey of these structures would be required if works to these structures was planned as part of the restoration. Findings of bat survey of identified features are included in the Table 2 below.

Table 2: Findings of bat survey of identified features

Map	Section	Tree/structure	Grid Ref.	Comment
12	3	ash	SK62748 36699	Well clear of canal bank on south side – hollow trunk, moderate potential
12	o	Oak	SK63121 36570	Within a small copse on north bank - moderate
12	3	beech	SK63267 36520	Broken branches –Moderate
16 - 18	5	willow	SK65682 35918, SK65841 35971 and SK66245 35972 to SK 66501 36206	Two long narrow plantations of Crack Willow with low potential at the moment – however should any succumb to damage through lightening etc. potential increases
16 - 18	5	ash	SK66037 35978	Between the two willow plantations - moderate
16 - 18	5	ash	SK66177 35978	Also between the Willow plantations –dead with high potential
19	6	ash	SK67236 36836	Several dead branches with high potential
2	12b	weeping willow	SK67591 30631	Negligible potential with no obvious roost possibilities
2	12b	ash	SK67627 30586	Moderate potential
2	12b	ash	SK67656 30564	Moderate potential
45	19	ash	SK74607 31622	A mature tree with moderate potential
46	19	Willow	SK74749 31672	Located just before bridge 44 – low potential
44	20	ash	SK75223 31918	Some broken off branches with moderate potential
53	23	willow + aspen	SK77533 35277	Group of willows plus aspen – the aspen having more potential than the willows

Map	Section	Tree/structure	Grid Ref.	Comment
54	24	ash	SK78086 35748	Although some cracks considered low potential
65	29	Bridge 59	SK83355 36801	Considered low potential
66	30	willow	SK83713 36622	Negligible potential
66	30	ash	SK83751 36596	Negligible potential
73	35	oak	SK87112 34211	Moderate potential
74	35	oak x 3	SK87308 34178	A group of three Oaks, one with staining from a 'wound'. However a larger hole a little higher had more potential and during the evening survey something was inside but wouldn't 'show'.
74	35	oak	SK87394 34127	Moderate potential –location opposite an area of Sycamore scrub
74	35	oak x 3	SK87415 34111	Moderate potential in this group
74	35	horse chestnut	SK87497 34071	Several fissures in bark
74	35	horse chestnut	SK87537 34012	As above
74	35	ash + alder	SK87578 33941	Moderate potential
74	35	horse chestnut	SK87625 33895	Group of trees with moderate potential
75	36	horse chestnut	SK88335 33840	Some fissures within bark low potential
75	36	horse chestnut	SK89072 33934	Some holes but low potential
75	36	ash	SK89713 34207	Moderate potential –location close to the A1

3.7.3 The canal corridor in general is highly suitable for use bats, as these species typically utilise linear features such as hedgerows and watercourses for foraging and commuting.

3.7.4 Evening emergence survey concentrated along the stretch covering sections 35 to 37, as these were considered to be the most likely section within which bats would be located. The oak tree with the staining located in Section 35 was particularly targeted with the night scope and something was detected within the upper hole but would not emerge for identification.

3.7.5 A number of common pipistrelle (*Pipistrellus pipistrellus*) were recorded flying along the towpath and one *Myotis* sp was detected near to Denton Bridge at the commencement of Section 35.

3.7.6 The timing of survey is likely to have influenced the numbers of bats seen/detected with a greater number most likely to be detected during the summer months and in better weather conditions.

3.8 Invertebrates

3.8.1 A very limited amount of information has been obtained from the Invertebrate Site Register (ISR) which lists two damselflies and three water beetles, mainly from poorly specified areas of the Grantham Canal. This information is displayed in Table 3.

Table 3: Information from the Invertebrate Site Register (ISR)

ODONATA (damselflies, dragonflies)					
Species	Status	NGR	Date	Recorder	Source
<i>Coenagrion pulchellum</i> Variable Damselfly	Nationally Scarce N(b)	(none)	1976	(none)	ISR
<i>Erythromma najas</i> Red-eyed Damselfly	Nationally Local	SK83	1986	John Redshaw	ISR
2					
COLEOPTERA (beetles)					
Species	Status	NGR	Date	Recorder	Source
<i>Hygrobia hermanni</i> Screech Beetle	Nationally Local	SK7431	1982	Derek Lott	ISR
<i>Ilybius fenestratus</i> a water beetle	Nationally Scarce N(b)	SK7431	1982	Derek Lott	ISR
<i>Ilybius quadriguttatus</i> a water beetle	Local: Leicestershire	SK7431	1982	Derek Lott	ISR
3					
5					

3.8.2 Discussion of the invertebrate interest of the Grantham Canal has been divided into consideration of aquatic/marginal habitats and terrestrial habitats.

Aquatic/marginal habitats

3.8.3 The aquatic invertebrate species recorded from the Grantham Canal SSSI are detailed in Table 4 below. The location of individual survey points is shown in figure 62 Appendix 1.

Table 4: Locations of aquatic invertebrate species recorded from the Grantham Canal SSSI

Taxa	Harby/Plungar Section					Plungar/Redmile Section				
	SO1	SO2	SO3	SO4	SO5	SO6	SO7	SO8	SO9	SO10
<i>Polycelis nigra/tenuis</i>								2	2	
<i>Valvata piscinalis</i>						1				
<i>Bithynia tentaculata</i>		2		1	5	3	2			
<i>Physa fontinalis</i>		1			6		2			3
<i>Lymnaea peregra</i>	1	1			2	2				2
<i>Lymnaea stagnalis</i>				1	1	1				1
<i>Planorbis carinatus</i>		3	3		8	5	1	1		
<i>Anisus leucostoma</i>	5		12		6	6	3			
<i>Planorbarius corneus</i>	6	3			2	1				3
<i>Acroloxus lacustris</i>						1				1
<i>Sphaeriidae</i>					2			2		
<i>Oligochaeta</i>					1		1			

Taxa	Harby/Plungar Section					Plungar/Redmile Section				
	SO1	SO2	SO3	SO4	SO5	SO6	SO7	SO8	SO9	SO10
<i>Erpobdella octoculata</i>	2				3	1				
<i>Asellus aquaticus</i>	1	5	1	1	8	3	4		2	1
<i>Crangonyx pseudogracilis</i>	2		6		6	14	9		6	
<i>Procladius bifidus</i>									1	
<i>Coenagrion pulchellum</i>	1		2		3	1	1			
<i>Ilyocoris cimicoides</i>	1									
<i>Notonecta glauca</i>	2				8		2			3
<i>Haliphus ruficollis</i> gp.							3			
<i>Hyphydrus ovatus</i>		1			6	3				
<i>Sialis lutaria</i>	2	2								
Limnephilidae							1			
<i>Limnephilus flavicornis/marmoratus</i>	5	2	1	3	7	4	6			1
Tanypodinae					2	1			1	
Orthocladinae					1	1				
Chironominae					1					

- 3.8.4 The aquatic and marginal habitats of the Grantham canal are characterised by still or slow-flowing nutrient-rich waters, and these habitat characteristics are evident in the invertebrate assemblage recorded, which is dominated by species typical of lowland, nutrient-rich 'ponds'. The taxa recorded are typically both common and widespread in nutrient-rich lowland waters and as such are of limited intrinsic nature conservation importance.
- 3.8.5 The key habitat of value to invertebrates associated with the canal corridor is the emergent vegetation fringe. The species richness of invertebrate communities of the Grantham Canal SSSI is likely to be highest in areas where plant communities are either well integrated or where distinct communities of predominantly different species lie proximal to each other

Terrestrial Habitats

- 3.8.6 The terrestrial habitats along the corridor are typically homogenous and unlikely to be of particular ecological importance in terms of the terrestrial invertebrate communities they support. The hedgerows are heavily managed with little deadwood and as such are of little interest to saproxylic invertebrate species.
- 3.8.7 The key terrestrial habitats of interest along the canal corridor comprise the terrestrial habitat mosaics present within the dry section, which may support a range of ephemeral and water dependent species, and mature and over-mature pollards containing deadwood likely to be of value to saproxylic invertebrate species. In particular, crack willow *Salix fragilis* is an important resource for a wide range of saproxylic (dead wood dependent) invertebrates (particularly beetles and flies) and the coarse fissate bark of older trees provides important over-wintering shelter for a wide-range of terrestrial invertebrate species.

- 3.8.8 The lack of deadwood in the hedgerow network restricts the connectivity of these resources and is likely to restrict invertebrate movements between features. In view of the relative isolation of many of these trees, they are considered unlikely to support invertebrate communities of greater than local or possibly district importance for nature conservation. However, this evaluation is of relatively low confidence pending further evaluation.
- 3.8.9 Whilst the invertebrate species list could be improved through survey in different times of year, the species recorded are considered representative of the communities present and it is considered unlikely that further survey would substantially alter this evaluation. Based on the habitats present and species recorded in 2006 it is considered unlikely that additional survey would reveal species or assemblages of high ecological importance.

3.9 Birds

- 3.9.1 Incidental records of bird species recorded in each section are included in Appendix 1. Key bird species are reed warbler and sedge warbler, which currently utilise areas of common reed swamp within the channel for breeding and foraging.

3.10 Amphibians

- 3.10.1 Egg and larval searches were carried out in several waterbodies within the dry section of the canal. These searches did not record great-crested newt, although this does not necessarily mean that this species is not present. No other water bodies considered to be particularly suitable for supporting great-crested newt were identified on or immediately adjacent to the canal.

3.11 Summary of nature conservation value

- 3.11.1 A summary of identified ecological receptors and their importance for nature conservation is presented in the Table 5 below. Rationale behind the individual evaluations is explained in section 3 and the method of evaluation is detailed in section 2. It is important to note that the evaluations given reflect the importance of the populations of species and the habitats actually present within the canal corridor. For example, grasswrack pondweed is considered to be of national importance the population present within the canal comprises a substantial component of the national resource of this species. Conversely a large number of trees both nationally and within the local area contain features that may be used by bats, and the presence of a single pipistrelle bat in a single tree would not necessarily be considered to be nationally or internationally important despite the higher level of legal protection they are afforded.

Table 5: Ecological receptors

Feature	Designation/legislation	Importance for nature conservation
<u>Designated sites</u>		
Grantham Canal Harby-Redmile SSSI	SSSI	National
Muston Meadows SSSI/NNR	SSSI	National
Kinoulton Marsh and Canal SSSI	SSSI	National
Various locally designated sites	SINC/SNCI/LWS	Local to county
<u>Habitats</u>		
Aquatic macrophyte communities		Local to County
Emergent vegetation communities		Local to County
Reedbed	UKBAP habitat	County
Bankside vegetation communities		Local to County
Hedgerows		Local/District
Terrestrial habitat mosaic		Local
<u>Species</u>		
Grasswack pondweed	UKBAP priority species. Nationally scarce	National
Bats	Protected under Habitat Regulations, WCA, CROW Act	District
Water vole	Habitat protected under WCA. Full protection pending	District
Great-crested newt	Protected under Habitat Regulations, WCA	District/County
Badger	Protection of Badgers Act	District
Grass snake	Partial protection under WCA	District
Aquatic macroinvertebrates		Local
Terrestrial invertebrates		Local
Birds	Various levels of protection under WCA	Local to County

4. Consideration of Alternative Restoration Options

4.1.1 In assessing the potential for the scheme to affect the ecological communities of the Grantham Canal, consideration has been given to the relative benefits and disbenefits of a number of potential restoration scenarios. Seven options for restoration have been considered, comprising two 'no restoration' options, and four options for 'full restoration', and one option for 'partial restoration'.

4.1.2 As no definitive proposals for restoration have yet been developed, this 'consideration of alternatives' aims to guide the development of the design of the restoration in order that the proposals can be developed to maximise ecological benefits and minimise ecological risks. The options considered are as follows:

1. Continue the existing level of management by British Waterways, without opening up the canal to further boat traffic.
2. Enhance the existing level of management by British Waterways without opening up the canal to further boat traffic.
3. Restoration to a 5 metre width of canal channel with unrestricted boat traffic.
4. Restoration to a 5 metre width of canal channel with restrictions on the level of boat traffic.
5. Restoration to a 10 metre width of canal channel with unrestricted boat traffic.
6. Restoration to a 10 metre width of channel with restrictions on the level of boat traffic.
7. Restoration of part of the canal without opening up the rest (e.g. the SSSI length) to boat traffic.

4.1.3 In assessing the restoration and management options consideration has been given to the adoption of management and restoration techniques with potential to enhance the existing ecological interests of the canal. Whilst some of the key ecological interest features, in particular the aquatic and emergent plant communities are currently in decline, remnant populations of key species and assemblages remain in some areas and there is great potential to improve the ecological value of the canal assuming management and restoration works are undertaken sensitively and proposals are guided by the ecological requirements of the site. Potential effects and impacts associated with the individual restoration options are detailed in the sections below. The relative potential benefits and disbenefits of the restoration options for the identified ecological receptors are summarised in Appendix 2.

4.2 'No Navigation' Options (Options 1 and 2)

4.2.1 These options assume that no part of the Grantham Canal is restored to navigation. Option 1, which considers the continuation of the existing management regime is equivalent to the 'no change' scenario, whereas Option 2 assumes an alteration to current management practice to confer maximum benefit to the ecological communities of the Grantham Canal.

Adoption of either of these options in the short term would not necessarily preclude restoration in the future.

Option 1: Continue existing level of management without opening the canal up to further boat traffic.

- 4.2.2 The key ecological interests of the Grantham Canal comprise its aquatic and marginal vegetation communities, for which various sections of the canal have been designated at both national and subnational levels. Of particular importance is the presence of grasswrack pondweed, which is considered to be of national importance for nature conservation.
- 4.2.3 The aquatic macrophyte communities of the Grantham canal have declined substantially in recent years, as evidenced by the most recent condition assessment of the Harby-Redmile SSSI. This can be attributed to a variety of factors working either alone or in combination including nutrient enrichment of the canal waters, likely to result primarily from natural succession processes leading to shallowing of the water body resulting in encroachment by marginal and emergent vegetation species, in particular common reed, which dominates much of the SSSI. Diffuse pollution from agriculture; disturbance and nutrient enrichment resulting from high populations of benthic cyprinids, which are present in many sections of the canal, are also likely to have contributed to the degradation of aquatic habitats.
- 4.2.4 Assuming that no intervention was to take place other than to maintain the existing level of management, the nature conservation interest of the aquatic macrophyte communities of the Grantham Canal can be expected to continue to decline, particularly in respect of grasswrack pondweed, which has become less widespread in the canal over recent years. If current management levels are maintained there is a risk that this species may be lost from the canal in the short to medium term.
- 4.2.5 The primary sources of risk comprise a combination of continued encroachment of emergent vegetation, sediment accumulation and nutrient enrichment, which increases the competitive abilities of robust species such as rigid hornwort.
- 4.2.6 Without changes to the existing level of management, vigorous marginal and emergent species such as common reed, bulrush and water soldier will continue to expand their ranges within the canal system reducing habitat availability for aquatic macrophytes and less strongly competitive marginal and emergent species. The overall diversity of the marginal and emergent communities can also be expected to decrease as the biomass of these species increases. As natural succession process continue the emergent vegetation communities will become simplified and will tend towards replacement by carr woodland and scrub in the long term.
- 4.2.7 The anticipated decline in the aquatic, emergent and marginal macrophyte communities of the Grantham Canal will result in declines in the ecological interest of designated sites that include these communities as ecological interest features in the site designation. These comprise the Grantham Canal Harby-Redmile SSSI, Kinoulton Marsh and Canal SSSI, Grantham Canal and Lock Pound SINC, Hollygate Bridge to Kinoulton SINC, Canal from Kinoulton to River Smite SINC and Grantham canal in Leicestershire SNCI.

- 4.2.8 Designated sites outwith the canal corridor are expected to be unaffected by this restoration option, with possible exception of Denton Reservoir and Knipton Reservoir, which are feeder reservoirs for the canal. These waterbodies are owned/managed by British Waterways. However, no survey of these features is known to have been undertaken in recent years and the current status of the waterbodies is unknown.
- 4.2.9 The majority of bridges along the canal corridor will continue to be unsuitable for use by roosting bats. The potential roosting opportunities associated with bankside trees is likely to increase slightly over time as individual trees mature. However, some loss of existing roosting potential is also likely to occur as currently suitable features deteriorate over time.
- 4.2.10 The value of the site for reed and sedge warblers is likely to continue to improve in the short to medium term but is likely to decrease in the long term as swamp and reedbed habitats succeed towards carr and woodland habitat types.

Option 2: Enhance the existing level of management by British Waterways without opening up the canal to further boat traffic.

- 4.2.11 Canal habitats are intrinsically man-made habitats and are not directly comparable with either riparian or still water communities. However, in terms of the aquatic vegetation communities typically supported within canals, the closest natural habitat type to canal communities can be considered to be represented by slow-flowing, lowland, nutrient-rich rivers. In such river habitats, natural hydrological processes, in particular winter flood conditions act to naturally arrest succession as floods maintain open channel via seasonal scouring of sediments, channel vegetation and natural loss of some bankside trees. In canal habitats this natural process can be emulated through sensitive management including sensitive phased dredging of sediments and removal of encroaching emergent vegetation, along with strategic coppicing and pollarding of some bankside trees.
- 4.2.12 The potential for changes to the existing management regime to affect the future ecological interests of the Grantham Canal would depend on the nature and level of management proposed. For the purposes of this assessment, the adoption of a 'Best Practice' approach to management has been assumed. Based on the current status of ecological features of the Grantham Canal, Natural England's 'Views About Management' in relation to the Harby-Redmile SSSI, and current management practices for aquatic habitats, the following actions have been assumed. It should be noted that adoption of this level of management would require substantial financial input, and that sufficient resources to undertake this level of work may not be available if the restoration does not proceed.
- 4.2.13 As discussed under Option 1, the ecological interests of the Grantham Canal in terms of its aquatic and marginal/emergent vegetation communities are currently in decline due to a range of factors including diffuse pollution from agriculture, high numbers of benthic cyprinids, and natural succession, including shallowing of the canal and encroachment by marginal and emergent species. The opportunities for addressing impacts resulting from diffuse pollution from agriculture are likely to be limited in the short term as this would require a change in land use practices throughout the catchment. However, targeted opening up of the canal corridor, including removal of

some sediments and marginal vegetation has the potential to benefit the canal, as does targeted removal of benthic cyprinids in areas where populations of these species are sufficiently high to compromise the ecological interests of the canal.

- 4.2.14 Currently the most ecologically interesting section of the Grantham Canal in terms of its aquatic macrophyte communities are the sections between Redmile and Woolsthorpe. These sections are characterised by relatively deep, clear water with limited encroachment by marginal vegetation. All records of grasswrack pondweed were obtained from these sections, and the aquatic macrophyte communities were generally more diverse in these sections and than in others with species including perfoliate pondweed (*Potamogeton perfoliatus*) and fan-leaved water crowfoot (*Ranunculus circinatus*).
- 4.2.15 An ideal management option would be to undertake an initial phase of dredging of the areas of the canal adjacent to the Redmile to Woolsthorpe section to promote the colonisation of these sections by reservoir populations of key species present between Redmile and Woolsthorpe.
- 4.2.16 Dredging of the section between Redmile to Bottesford Wharfe (see Figure 2) would promote colonisation of key macrophyte species adjacent to the SSSI, and dredging of the Harby-Redmile SSSI would have potential to improve the condition of the designated site if undertaken sensitively and utilising a phased approach, supported by appropriate monitoring between dredging phases.
- 4.2.17 This could be supplemented by appropriate translocation works if necessary. This would have potential to benefit the aquatic macrophyte and emergent communities of the Grantham Canal, although it should be appreciated that ongoing management would be required to maintain the ecological interest in the longterm.
- 4.2.18 In order to achieve maximum ecological benefit works would be required along the length of the waterway, including an extensive programme of phased dredging, targeted removal of encroaching marginal vegetation and tree management works.

Option 3: Restoration of the canal as a 5 metre width of canal channel with unrestricted boat traffic.

- 4.2.19 In order to assess the potential impacts of this option it will first be necessary to generate predictions about the level of potential boat activity on the newly restored canal. Previous studies undertaken by Murphy *et al* (1995) have indicated that boat movements of up to 500 passages a year can occur without necessarily causing negative impacts to aquatic plant diversity in waterways. A low level of disturbance can help maintain an open channel suitable for colonisation by a broad range of macrophyte species.
- 4.2.20 Once boat movements rise above this level, in general species diversity begins to decline. It should be appreciated that the threshold may vary depending on species present, channel structure, depth, substrate type, bank type and sediment quality and that 500 boat movements is an indicative figure and impacts need to be assessed on a site specific and iterative basis.

- 4.2.21 The restoration as proposed does not include connection to the main waterway network at the River Trent, which means that boat activity could be expected to be lower than would otherwise be the case. However, the canal is in an attractive rural catchment and is likely to attract great interest from recreational boaters once restored. Once the main canal is restored it does not seem unreasonable to expect that further restoration might be promoted with the long term goal of connecting to the Trent and it is this long term view that we must take when considering unrestricted boat movements.
- 4.2.22 Restoration to 5m width allows for two narrow boats to pass. The canal is typically around 10 m wide and restoration of a 5 m width of channel would superficially appear to allow channel margins of up to 5 m to remain undisturbed, particularly on the offside. However, there is potential for disturbance to these margins to occur either from direct physical disturbance by boats, or disturbance caused by wave action from the wash of boats. The effects of wave wash are likely to be particularly pronounced in a 5 m channel as little time and distance is available for the wave energy to dissipate.
- 4.2.23 In addition, a key ecological interest of the canal is its aquatic macrophyte communities, in particular grasswack pondweed. This species typically grows in open water of between 1-1.5 m depth. Retaining an unrestored 5 m margin along the canal will mean that the only suitable habitat within the channel available for this species will comprise the navigation channel itself. Concentrating boat movements over a narrow section of channel will adversely impact this species, as the level of disturbance, via direct physical disturbance to individual plants, wave action and increased turbidity will be concentrated over a small area that comprises the key habitat for grasswack pondweed within the canal.
- 4.2.24 Assuming restoration is undertaken sensitively to include recovery and subsequent reintroduction of plant material, phased dredging over an extended period, and sufficient time for canal communities to regenerate prior to opening, it should be possible to minimise the potential impacts of the construction phase of the restoration.
- 4.2.25 The distribution of fish populations, in particular dense populations of benthivorous cyprinids is currently influenced by in-channel obstructions such as double pipe culverts and reedbeds. Restoration of the canal would remove these obstructions allowing fish to spread through the canal system more easily. Whilst this may be of some benefit to areas that are currently severely impacted by fish activity, there is a risk that higher density fish populations could become resident in areas that are currently of higher ecological value in terms of the submerged aquatic plant communities. This could have negative impacts on these communities and would require consideration during the detailed design of the restoration process.
- 4.2.26 Opening the channel would also make angling easier than at present and may lead to increased pressure for additional fish stocking or unauthorised introductions of fish. Whilst fish species such as roach, rudd, perch and gudgeon are unlikely to adversely affect the other ecological interests of the canal, if large carp or bream were introduced this could have a severe adverse effect on the aquatic macrophyte communities of the canal which, in view of the high conservation importance of these communities could be considered to be of significance at up to a national level depending on the areas affected.

- 4.2.27 There is potential for restoration of the canal to adversely impact the reed and sedge warbler populations as a consequence of removal of common reed reedbed. However, as large areas of reedbed would remain any effects on these species are likely to be slight, with little effect on the populations of the canal corridor overall. The significance of potential impacts is therefore likely to be low. Restoration to 5 m would have the advantage of leaving marginal vegetation of potential value to terrestrial invertebrates undisturbed, and would retain a food source for water vole populations within the canal corridor.

Option 4: Restoration of the canal as a 5 metre width of canal channel with restrictions on the level of boat traffic.

- 4.2.28 This option would entail limiting of boat numbers to appropriate levels to avoid impacts to aquatic macrophyte communities of nature conservation importance. This would enable assessment of community change to be undertaken on an iterative basis following the restoration to allow for both maximum nature conservation and boating interest.
- 4.2.29 With restrictions on numbers of boat movements, areas of activity are likely to be largely restricted to the centre channel as there will be less passing boats. This should allow submerged aquatic macrophytes to persist at the channel margins. However, as in Option 3 above, the restored width would be very narrow and direct disturbance and wave action may still be too high to comprise ideal habitat for aquatic macrophyte species that are intolerant of such conditions such as grasswack pondweed. If this option is adopted it will be necessary to have an active program of monitoring and to have reliable systems of boat movement assessment and control. Impacts to sensitive aquatic macrophyte species are likely to result from lower numbers of boat movements if a 5 m width channel is restored than if the 10 m width were restored due to the restricted nature of the channel.

Option 5: Restoration of the canal as a 10 metre width of canal channel with unrestricted boat traffic.

- 4.2.30 The same principles apply here as in the option to restore to 5m width with unlimited boat movements. However, restoring to 10m width has a number of distinct advantages in maintaining the nature conservation value of the site in terms of the submerged aquatic vegetation communities.
- 4.2.31 The wider restored channel will result in less direct disturbance from boats on submerged species and additionally the effects of underwater turbulence produced by boats will be reduced. However, unlimited boat movements will still create elevated levels of turbidity through sediments being suspended in the water column as unlimited boat movement is likely to allow insufficient time for settlement of sediments between boat movements depending on the level of boat movements predicted.
- 4.2.32 Restoration of a 10 m width will allow areas of channel to be designated to be either free of boat movement or directly protected via in-line reserves. Whilst the success of this method is still in assessment some noticeable success has been achieved on the Rochdale canal with in-line reserves created for floating water-plantain (*Luronium natans*) Figure 3. It should however be noted that this species requirements are different to the majority of the receptors identified in this study that require deeper open water.

- 4.2.33 There is greater potential for negative impacts to sedge and reed warblers, aquatic and terrestrial invertebrates and water vole if this option is adopted as virtually all marginal and emergent vegetation would be removed.

Option 6: Restoration of the canal as a 10 metre width of channel with restrictions on the level of boat traffic.

- 4.2.34 This would allow passing and restricted/reserve areas for aquatic macrophyte communities to be created but the key to the success of this method of restoration would be to allow sufficient time for recovery of macrophyte communities following restoration. Monitoring of the canal communities would need to be undertaken to determine when sufficient recovery had taken place and it is likely that one or more years would be required for recovery to take place.
- 4.2.35 Whilst translocation could help this process it may not be beneficial to allow navigation immediately following restoration and plant community recovery must be seen as a restoration process, not merely overcoming engineering obstructions and challenges.
- 4.2.36 Restricting boat movements has the ecological benefit of reducing effects of boat traffic resulting from direct disturbance, re-suspension of labile sediments and wave action resulting from wash. In addition, occasional boat passages will help to maintain an open central channel with reduced biomass of competitive species such as rigid hornwort.
- 4.2.37 Other impacts would generally remain as stated in Option 5.

Option 7: Restoration of part of the canal without opening up the rest to boat traffic.

- 4.2.38 This option would potentially allow for sources of inoculums for restored section however this would require an active commitment to the management of the unnavigated section otherwise the situation may be reached where heavy navigation of the restored lengths results in species diversity decline in these areas and management neglect results in species decline in the unnavigated section.
- 4.2.39 As the section of canal between Woolsthorpe and Redmile is of key importance in terms of its aquatic macrophyte communities, consideration could be given to retaining this section as unnavigated if this restoration option was progressed.

4.3 Consideration of Restoration Options

- 4.3.1 In determining the best option the potential for each option to result in the best functioning ecological system suited to the identified receptors must be considered. Details of the approach to restoration must be developed as an integral part of the detailed design. However, from an ecological perspective it would be desirable to incorporate the following key concepts:
- Survey has identified the section of the canal between Redmile and Woolsthorpe as being the most botanically diverse section in terms of its aquatic macrophyte communities. Ideally restoration should be undertaken either side of these communities in the first instance to allow the

communities of particular conservation importance to recolonise newly restored habitats, perhaps aided by translocation. Once the species have become established in the newly restored canal the rest could either be restored and monitored vigorously or remain unboated and actively managed.

- Restoration of the canal to 10 m channel width has potential to benefit aquatic macrophyte communities of conservation importance. However, this option also has potential for higher adverse impacts to marginal communities as well as invertebrates, birds and water vole. Consideration should be given to restoration of different sections of the canal to different widths to minimise overall impacts on ecological receptors.
- Sufficient time (informed by ongoing monitoring) should be left between completion of restoration and commencement of navigation to allow some regeneration of communities of ecological importance to occur.
- Restricting the number of boat movements will minimise impacts to aquatic macrophyte communities regardless of the width of channel restored.
- If restoration to navigation is progressed then areas should be identified for creating undisturbed reserve areas containing key receptors. These should include a combination of in-channel and offline reserve areas as utilised on the Rochdale Canal SAC and Montgomery Canal SAC.

4.3.2 A summary of the relative impacts of the different restoration options on identified receptors is included in Appendix 2. Suggested priorities for phased restoration are shown in Figure 2.

4.3.3 It can be seen from this table that the ideal option for restoration from an ecological perspective would comprise Option 2: Enhancing the existing level of management without opening the canal up to boat traffic. Other options have potential to benefit different interest features, however, blanket adoption of any one of these options would be likely to have significant adverse effects on one or more of the species or habitats currently present within the canal corridor. Options that include limiting navigation are preferred to those including unlimited navigation.

4.3.4 If restoration for navigation is to be undertaken the preferred option would be to adopt a variable and phased approach to restoration to include restoration of some sections to 10 m, which would provide suitable habitat for key aquatic macrophyte species such as grass-wrack pondweed and restoration of some sections to 5 m, which would enable retention of reedbed corridors and associated habitat for bird species.

4.3.5 Detailed proposals for restoration, including specification of dredging profiles and determination of whether restoration is to be to 5 m or 10 m in appropriate locations would need to be developed prior to any restoration being undertaken. Examples of dredging profiles used on the Rochdale Canal SAC are included as Figure 9.

4.3.6 Regardless of the restoration width, limiting the numbers of boat movements permitted along the restored canal will be key to ensuring that adverse effects to the ecology of the canal are avoided.

5. Impact Assessment and Mitigation

5.1.1 The potential effects of the restoration and subsequent operation of the Grantham Canal on its key ecological features are discussed below. The assessment has been undertaken based on the assumption that a variable and phased approach to restoration is adopted and that boat movements are monitored and where necessary restricted to minimise adverse effects on aquatic macrophyte communities.

5.1.2 It is important to recognise that the majority of mitigation proposals will require substantial resources in terms of both time and money. Appropriate budgets for undertaking this element of the works must be allocated within the overall restoration budget.

5.2 Aquatic macrophytes

5.2.1 The majority of aquatic macrophyte species within the Grantham Canal currently comprise species of limited intrinsic conservation importance. Whilst some decrease in the abundance of aquatic vegetation will be associated with the restoration the canal, the communities that will be affected are typically characterised by species typical of eutrophic waters such as rigid hornwort and waterweed. These species currently dominate the aquatic macrophyte communities of the Grantham Canal to the detriment of more ecologically important species and as such removal of a proportion of these communities has potential to comprise a beneficial effect to the aquatic macrophyte communities of the canal in the medium to long term.

5.2.2 Dredging of the canal to navigable depth will increase the depth of the canal to around 1.3 m. This water depth is preferred by key aquatic macrophyte species such as grasswack pondweed and has potential to increase the suitability of the physical habitats present for this species. However, the effects of boat traffic during the operation of the restored canal, in particular elevated turbidity and direct disturbance have potential to compromise colonisation and persistence of this species once the canal is opened to navigation. As grasswack pondweed currently persists in discrete areas of the canal, and the population present is considered to be of national importance to nature conservation, if such an effect were to occur it would be considered to represent a severe adverse impact. Such an impact would be of particular importance as it would affect the integrity of grasswack pondweed populations within the canal and would therefore be considered to be significant at a national level.

5.2.3 To prevent such an impact occurring a phased approach to restoration is suggested. Initial restoration should focus on areas immediately adjacent to existing populations of grasswack pondweed. Restoration of the section of canal from Redmile to Bottesford Wharfe should form one of the first stages of the restoration, which should include removal of water soldier, which is becoming invasive in this section.

5.2.4 Restoration of this section should include restoration of areas to a 10 m width to maximise the suitability of habitats for grasswack pondweed, although the retention of a narrow emergent fringe may be desirable from a visual perspective as well as to maintain connectivity of marginal habitats. Retention of a fringe of marginal vegetation would also help stabilise the canal banks, particularly on the offside, which would reduce the potential for

erosion of banks and associated sediment dispersal and resultant increased turbidity within the canal.

- 5.2.5 On completion of restoration the recovery of aquatic macrophyte communities should be monitored as key macrophyte species such as grasswrack pondweed may recolonise naturally. If natural recolonisation by this species does not occur then consideration should be given to introducing populations of this species from adjacent sections (Figure 4).
- 5.2.6 Recent research undertaken by ECUS Ltd on behalf of Natural England suggests that grasswrack pondweed is likely to be fairly easy to reintroduce to sites from which it has been lost. Turions can be gathered from parent plants in late summer and either reintroduced directly or transplanted into a suitable growing medium in early spring and allowed to start growth before being introduced into the canal with the growing medium. This approach has the advantage of facilitating the early establishment of plants and enabling monitoring of establishing vegetation as the area of introduction is more precise. Details of appropriate reintroduction methodologies can be found in 'Ecological requirements of grasswrack pondweed' (Natural England, in press). A diagram outlining the approach used successfully for previous projects is included as Figure 4
- 5.2.7 Following completion of the restoration of the Redmile to Bottesford Wharfe section, the second stage of restoration should focus on the Harby to Redmile SSSI section. However, this should not be undertaken until the success of the previous stage of work has been established through monitoring. The SSSI is currently highly degraded and has lost much of the botanical interest for which it was designated and inappropriate management in recent years has contributed to this degradation. Due to the designated status of this section restoration must be undertaken with particular sensitivity to ensure that the designated ecological features of the SSSI are enhanced by the restoration process. Restoration of this section of the canal should include restoration of some areas of the canal to 10 m width to benefit the aquatic macrophyte communities and restoration of other sections to 5 m width to retain areas of common reed reedbed and diverse marginal vegetation fringes where this does not compromise the aquatic vegetation communities. An assessment will be required prior to commencement of works to determine preferred dredging widths in individual locations.
- 5.2.8 In view of the sensitivity of this section of the canal staggered dredging should be undertaken over a number of phases (at least four) starting with the upstream section to facilitate recolonisation by grasswrack pondweed from adjacent upstream areas. Monitoring of the recovery of early phases should be undertaken to inform the later phases and works to this section must be undertaken in close consultation with Natural England. As with the Bottesford Wharfe to Redmile section consideration should be given to phased reintroduction of key species if colonisation does not occur naturally.
- 5.2.9 Restoration of the Bottesford Wharfe to Stenwith Section, the only remaining location for grasswrack pondweed on the Grantham Canal should only be undertaken following the successful establishment of the species in adjacent restored sections. Restoration of this section should also pay particular attention to other key species present within this area such as perfoliate pondweed (*Potamogeton perfoliatus*). Populations of these species should

be rescued prior to restoration and retained for replanting on completion of the restoration of the section.

- 5.2.10 Restoration of all three of these sections should include creation of dedicated reserve areas for key macrophyte species within the 10 m width restored channel. Suitable reserve areas can be created by installing geotextile curtains at the edge of the required navigation width, as used on the Rochdale Canal. The restoration of the entire width of canal in these sections will ensure that suitable water depths for grasswack pondweed are created and the use of geotextile silt curtains will help minimise turbidity and disturbance by wave action from boat traffic following the opening of the canal for navigation.
- 5.2.11 Consideration will need to be given during the restoration for the potential for the restoration of the canal to increase the availability of habitat for high density fish populations due to the removal of narrow pipe culverts, which currently comprise a partial barrier to fish movement from areas with high density populations to other sections where large benthivorous fish are currently so prevalent. Large bottom feeding fish such as carp and bream can adversely affect macrophyte communities by uprooting shallow rooted species such as grasswack pondweed. They also increase the turbidity of waters and grasswack pondweed is intolerant of highly turbid conditions and can act as 'forward switches' in eutrophication events. Strategic management of high density fish populations in areas identified as key for such macrophyte species may be required to prevent adverse impacts to these plant communities.
- 5.2.12 Whilst it is considered likely that the restoration of the canal will benefit aquatic macrophyte communities overall assuming that such restoration is undertaken sensitively as discussed in the paragraphs above, there is potential for the operation of the restored canal to adversely affect aquatic macrophyte communities. Boat movements in excess of 500 per year have been found to adversely affect aquatic plant communities and due to its shallow rooting nature and intolerance of turbid conditions, grasswack pondweed is likely to be particularly susceptible to disturbance from boat traffic. The creation of inline reserve areas will help to minimise any effects, however, it will be necessary to monitor the effects of boat traffic and it may be necessary to limit boat movements, for example by installing and monitoring boat counters and restricting boat access at key points along the canal, if significant adverse impacts to aquatic macrophyte communities are to be avoided. The mechanism by which any such scheme could be implemented would need to be determined prior to restoration by the navigation authority.
- 5.2.13 There is also considerable potential for the restoration of the canal to benefit aquatic macrophyte communities if bypass channels can be created to create offline reserve areas dedicated to aquatic macrophyte conservation. These could take the form of adjacent sections of newly created channel dedicated to macrophyte conservation as currently being trialled on the Montgomery Canal (Figure 7), or alternatively existing 'loops' in the canal could be cut off and new channel created to bypass these areas for navigation, enabling the existing canal to be prioritised for aquatic macrophyte conservation (Figure 8). Any potential locations would be subject to further study to establish their feasibility for reserve creation from an engineering perspective, as well as requiring ecological survey prior to creation to ensure that they do not

currently support features of nature conservation importance that would be adversely affected by the reserve creation.

- 5.2.14 Whilst it would not necessarily be possible or required to create areas of reserve channel in all identified potential locations, a precedent for creation of such areas exists on the Montgomery Canal, and creation of even a single bypass channel could offer significant nature conservation benefits compared to all restoration options and the existing baseline if this could be achieved.
- 5.2.15 In summary, whilst the restoration of the Grantham Canal will pose risks to its aquatic macrophyte communities, such risks pose no more threat to these communities than the 'no change' scenario, which is highly likely to result in the loss of the remaining aquatic macrophyte interest of the canal. Restoration of the canal if undertaken sensitively as described above has potential to result in beneficial impacts to these communities that would be significant at up to a national level. A greater level of risk is associated with the use of the canal by boat traffic during the operational phase of the restoration. However, the creation of appropriate inline and offline reserve areas and monitoring and if necessary limiting of boat traffic would help ensure that the restoration would have beneficial impacts on these communities overall.

5.3 Emergent vegetation communities

- 5.3.1 The restoration of the Grantham Canal will require control and removal of areas of marginal and emergent vegetation, including areas of species-rich emergent fringe, particularly on the towpath side. However retaining offside emergent fringes throughout the canal corridor would ensure that the connectivity of these habitats was not compromised by the restoration.
- 5.3.2 Priority should be given to ensuring that areas of diverse emergent vegetation fringe on the towpath side are retained and replanted, perhaps on the offside in areas where the marginal fringe is sparse or species-poor if engineering constraints mean that retention of these species-rich communities on the towpath side is impractical in localised areas, such as key mooring points or areas of hard bank. Particular consideration should be given to retaining fringes that are not dominated by reed sweet-grass and common reed as these species have strongly competitive growth habits and tend to replace less competitive species.

5.4 Reedbed

- 5.4.1 Restoration of the canal will require removal of some sections of common reed reedbed, a priority habitat in the UKBAP. The magnitude of this impact should be minimised by taking the opportunity to retain some areas of reedbed either in basins or winding holes or by selectively restoring some areas currently dominated by reedbed to 5 m width only to retain a band of reedbed in some sections of the canal. The opportunity could be taken to create new wider sections of canal or winding holes for reedbed creation if this was considered to be a conservation priority at the time of restoration.
- 5.4.2 Creation of offline reserve areas could also include creation of some areas of reedbed, particularly if reserves designs are similar to those created on the Montgomery Canal, which include an initial reedbed 'settling pond' at the

upstream end of the reserve to improve water quality prior to its inflow into the main reserve area (Figure 7).

5.5 Bankside vegetation communities

- 5.5.1 Some areas of canal bank on both the offside and towpath side are relatively species-rich. These communities are unlikely to be affected by the proposed restoration except in localised areas, for example if sheet-piling is required. Should engineering works to banks be required then planting of amenity grass seed mixes on disturbed ground should be avoided.
- 5.5.2 Disposal of dredgings directly to the banktop should be avoided wherever possible to avoid impacts to species-rich bankside vegetation communities.
- 5.5.3 Ensuring that any planting associated with the restoration utilises only locally appropriate native species of UK provenance would represent a nature conservation benefit to terrestrial habitats within the canal corridor.
- 5.5.4 Consideration could be given to avoiding backfilling of sheet-piled areas to promote the development of marsh and wet grassland and herb communities.

5.6 Hedgerows

- 5.6.1 Restoration of the canal corridor is likely to include disturbance to and removal of some sections of hedgerow to allow access with machinery. There may also be a requirement to manage some currently overgrown and unmanaged hedgerows on the offside to permit boat access.
- 5.6.2 Whilst loss of sections of hedgerow would comprise an adverse impact that would affect the integrity of the individual hedge, the hedgerows present along the canal corridor are typically of low species-diversity. If the opportunity was taken as part of the restoration to replant areas of disturbed or gappy hedgerow with appropriate species-rich hedgerow then this could represent a beneficial impact that would be significant at the level of the individual hedge.

5.7 Terrestrial habitat mosaics

- 5.7.1 The Cotgrave to Mackleys Farm section of the canal currently comprises ruderal vegetation interspersed with wet and dry grassland and small water bodies. Whilst these habitats do not represent particularly diverse botanical communities they add structural diversity to the habitats present within the canal corridor and are likely to support a range of invertebrate, small mammal, amphibian and reptile species, including grass snake and possibly great-crested newt. The restoration of the dry section will lead to the loss of these habitats, which will represent an adverse impact to the habitats and species present within the immediate area.
- 5.7.2 The significance of this impact could be reduced by seeking to incorporate areas of wet grassland creation and associated small pools into the areas highlighted for reserve creation.

5.8 Bats

- 5.8.1 Whilst no evidence of bat roosts was recorded from canalside trees at the time of survey, a number of trees containing cracks and crevices potentially suitable for bat roosting are present along the canal corridor and the restoration may require management or felling of some trees with some potential to support roosting bats. If loss of a bat roost were to occur this would represent an adverse impact at the level of the individual roost, although the significance of such an impact would depend on the type of roost and species of bat present. Where felling or management of mature trees is required trees should be checked prior to works being undertaken to ensure that no bats are present. Survey should be undertaken sufficiently in advance of works to allow time for appropriate method statements to be developed and licenses to be obtained.
- 5.8.2 As the majority of road crossings currently comprise double pipe culverts that are unsuitable for bats, the restoration has the potential to create favourable bat roosting habitat by incorporating bat friendly features into the design of new structures. This could include incorporation of purpose built bat bricks into new bridges and culverts and would be considered to represent a benefit to bats utilising the canal corridor due to the currently limited roosting potential associated with canalside structures (Figure 5).
- 5.8.3 Where existing bridges with areas of missing pointing are present these should be checked by a licensed bat worker prior to any works to these structures being undertaken to ensure that bats have not become resident in these structures since the completion of this study. Where possible areas of unpointed brickwork considered to have potential to support bats should be retained. If retaining such areas is not possible then replacement roosting potential should be installed on to the restored structure.
- 5.8.4 Should bat roosts be discovered in trees or structures that will be affected by the development then all works that may disturb bats must be undertaken under licence from Natural England. It should also be appreciated that almost any crack or crevice may be utilised by individual or transient bats from time to time. If bats are discovered on site at any time then works must be halted in the immediate area and an appropriately trained, qualified and licensed ecologist consulted immediately.
- 5.8.5 There is some evidence that dense accumulations of free-floating aquatic plants such as duckweed can reduce the favourability of waterbodies for foraging Daubenton's bat (*Myotis daubentonii*) (Boonman *et al* 1998). Restoration of the canal will increase through-flow of water, which will lead to decreased abundance of duckweed and therefore may have the potential to improve the canal habitats for foraging bats.

5.9 Water vole

- 5.9.1 The main threat to water vole on the Grantham Canal is considered to be displacement/extinction by mink. However, there is potential that water vole may become more prevalent along the canal corridor in future, particularly if methods for effective control of mink populations are developed. The restoration should seek to maintain favourable habitat for water vole so that the canal will be available for recolonisation of this species in future. Appropriate approaches would include retaining fringes of emergent

vegetation, including use of gap planting where necessary. Where bank protection is required use of soft engineering solutions such as coir rolls is preferred as this will maintain foraging and burrowing habitat for water vole (Figure 6).

- 5.9.2 Restoration of some sections of the canal to 10 m sections is not considered likely to have significant adverse impacts on any water vole populations currently resident within the canal corridor, as this species is considered to be present at very low population density and may already have been lost from much if not all of the canal corridor. Whilst reedbed offers potential value to this species (if/where present) as a foraging resource it does not offer burrowing opportunities. Sufficient marginal vegetation would remain in the event of restoration to provide ample foraging opportunity for any water voles present. However, further survey will be required immediately prior to restoration to ensure that the status of this species on site remains the same as during 2006 survey.
- 5.9.3 The footprints of proposed engineering works should be checked prior to works being undertaken to ensure that no water vole are present within the footprint of works. If water vole are discovered then works will need to be undertaken in line with a project-specific method statement to be agreed with Natural England prior to commencement of works to ensure that the works do not harm water vole or their habitat. Such a method statement may include maintaining an appropriate standoff from water vole burrows (3 – 5 m), or temporary exclusion of water vole from the working area.
- 5.9.4 As mink hunt primarily along linear watercourses, the incorporation of suitable water vole habitat into reserve areas would help create refuges for any water vole present within the local area.

5.10 Great-crested newt

- 5.10.1 Great-crested newt may be present in isolated ponds and pools within the Cotgrave to Mackley's Farm section (dry section). For a waterbody to be suitable for great-crested newt breeding it should include areas of emergent vegetation and open water, be subject to occasional drying out and should not contain fish. This is because many fish species such as sticklebacks and crucian carp feed on great-crested newt larvae. As a consequence great-crested newt rarely coexist with fish populations in the long term.
- 5.10.2 The rewatering of the dry section will result in the loss of existing ponds and pools present within the section. If great-crested newt are present within this section then this would be likely to represent loss of great-crested newt breeding and/or foraging habitat and could result in the localised extinction of great-crested newt from the canal corridor. This would represent a severe impact to any populations of this species present. The significance of the impact would be dependent on the size and status of the population affected, but would be significant at least a local, and more likely a district level.
- 5.10.3 The status of great-crested newt along the canal corridor should be established prior to restoration, in particular the presence or absence of this species in the Cotgrave to Mackley's Farm section should be established and the size and status of any population present investigated prior to commencement of works. Survey should be undertaken sufficiently in

advance of works to allow time for appropriate method statements to be developed and licenses to be obtained.

- 5.10.4 If great-crested newt are found to be present then any works that may affect this species must be undertaken under licence from Natural England and must be undertaken following a detailed method statement that will form part of the licence application. Natural England are highly unlikely to grant a licence for any works likely to result in a net loss of great-crested newt habitat. Where loss of a breeding pond will occur, a 'two for one' approach to replacement habitat creation is typically required.
- 5.10.5 Whilst the details of licensable works must be finalised shortly prior to restoration once the status of any newt population has been established and the detailed design of the scheme finalised, if breeding populations of great-crested newt are present within the dry section then creation of appropriate alternative habitat will be required. This is likely to include creation of breeding ponds and translocation of great-crested newt from their current habitat utilising a combination of methods including drift fencing, pitfall trapping and possibly bottle trapping of existing habitat. The replacement habitat will need to be created sufficiently in advance of the translocation of newts from their current habitat to enable the habitats including aquatic and marginal vegetation to become established prior to receiving the newts. As newts spend most of their life out of water the habitat creation scheme will have to incorporate creation of suitable terrestrial habitat for newts, including tall grass and herb communities and hibernacula. Hibernacula can be created using deadwood and rubble to provide shelter.

5.11 Badger

- 5.11.1 Restoration of the canal is likely to require some level of disturbance to badgers and their setts. In particular, the badger sett in the embankment at Colston Bridge (section 9) is likely to require removal, and a number of smaller outlier setts are present on the offside and may be subject to disturbance if, for example bank reinforcement or piling is required close to a sett.
- 5.11.2 Loss of, or disturbance a badger sett would represent a severe adverse impact to badgers at the level of the individual features and would be likely to be significant at a local to district level depending on the size and status of the affected sett.
- 5.11.3 If disturbance to badgers or their setts is anticipated a Natural England licence will be required for any works that require use of heavy machinery within 30 m of an active badger sett, or piling within 50 m. Licensed works must be undertaken outside of the badger breeding season and it unlikely that a licence to disturb badgers or their setts would be obtainable between December and June.
- 5.11.4 Where loss of a badger sett cannot reasonably be avoided then an equivalent replacement artificial sett should be provided. Replacement sett designs vary, but setts are typically constructed from breeze blocks, with entrance tunnels formed by clay pipes of minimum 30 cm diameter. The sett should be overtopped with chain link fencing and buried. Whilst other designs for making artificial setts exist, this approach is preferred as it minimises the potential for human interference to the sett. The high level of public access

on the canal, particularly following restoration, means that this more secure approach to sett creation is preferred.

- 5.11.5 As badgers are a highly mobile species and will readily colonise new habitats, updated badger survey will be required prior to commencement of restoration to ensure that the extent of badger activity and locations of badger setts are established prior to commencement of works. Survey should be undertaken sufficiently in advance of works to allow time for appropriate method statements to be developed and licenses to be obtained.

5.12 Grass snake

- 5.12.1 The restoration of the canal will require temporary disturbance to grass snake habitat particularly tall bankside vegetation on the towpath side and offside, along with tall herb and scrub habitats typically associated with embankments above culverts. There is some potential for animals to be harmed if such disturbance is undertaken in cold weather as grass snake are cold blooded and require the warmth of the sun to build up energy for movement. This potential impact can be avoided by either undertaking clearance of suitable grass snake habitat at temperatures of above 12 °C whenever possible. Where clearance of or substantial disturbance to grass snake habitat is unavoidable at lower temperatures then the area to be disturbed should be checked by an appropriately experienced and qualified ecologist immediately prior to works being undertaken to ensure that no snakes are present within the working area. Any snakes found to be present within the working area should be removed to pre-identified areas of suitable adjacent habitat.
- 5.12.2 The rewatering of the dry section will reduce the suitability of this area for grass snake and will effectively comprise permanent landtake of grass snake habitat in this area. This is considered to represent a slight adverse impact to grass snake. However, as the animals present are likely to readily relocate to adjacent areas, particularly if offside vegetation is retained this is unlikely to comprise a significant effect to grass snake, except within its immediate zone of effects. Nonetheless, the loss of these habitats will reduce the overall area of grass snake habitat associated with the canal corridor. Consideration should be given to incorporating creation of tall grass and herb communities and associated waterbodies into any areas of habitat creation associated with the scheme.
- 5.12.3 To ensure that connectivity of habitats for grass snake is retained then long grassland and ruderal habitats should be retained wherever possible. This is most likely to be achievable on the offside.

5.13 Aquatic macroinvertebrates

- 5.13.1 The aquatic invertebrate assemblages of the Grantham Canal are dominated by species typical of still or slow-flowing nutrient-rich waters. Assuming that boat movements are maintained at levels suitable for maintaining aquatic macrophyte populations of conservation importance it is considered unlikely that the operation of the canal will adversely affect the aquatic invertebrate communities present.
- 5.13.2 The creation of reserve areas suitable for colonisation by sensitive macrophyte species is likely to result in creation of more favourable aquatic invertebrate habitat than is currently present through much of the canal as

increased water quality anticipated in these reserves will promote the development of more species-rich invertebrate assemblages than are currently present.

5.14 Terrestrial invertebrates

5.14.1 The key habitats of importance for water-dependent terrestrial and marginal invertebrate species within the Grantham Canal corridor are the wet grassland and ruderal mosaics present within the dry section. The rewatering of this section will result in loss of habitat for the species present. As with grass snake, the opportunity should be taken if possible to recreate wet grassland habitats to provide alternative habitat for invertebrates currently utilising the dry section.

5.14.2 Where tree management works are required, for example to remove overhanging limbs, then felled wood should be retained on site wherever possible. The opportunity should be taken when undertaking such works to create deadwood habitat piles adjacent to the canal, perhaps on or adjacent to the offside bank. Such microhabitats are known to be of value to a wider range of invertebrate taxa, in particular saproxylic (deadwood) species, as well as small mammals, reptiles and amphibians.

5.15 Birds

5.15.1 Nesting birds are protected under the Wildlife and Countryside Act 1981 as amended. To avoid impacts to nesting birds, vegetation clearance should be undertaken outwith the bird-breeding season (March to August inclusive), where possible. Should clearance within the breeding season be unavoidable no such works will be undertaken until the site has been inspected by an appropriately trained, qualified and experienced ecologist to ensure that no nests are disturbed.

5.15.2 The loss of some areas of reedbed will reduce the availability of habitat for warbler species such as reed and sedge warbler as well as reed bunting, which currently utilise these habitats. However, ensuring that some sections of reedbed are retained as detailed above will minimise habitat loss and ensure that the effects of loss of reedbed habitat on these species are slight and are not significant to nature conservation outwith their immediate zone of effects.

6. Summary and Recommendations

6.1.1 The aquatic habitats of the Grantham Canal are currently degraded due to a number of factors but principally a combination of natural succession, excessive accumulations of sediments and nutrient enrichment.

6.1.2 If undertaken sensitively, the restoration of the Grantham Canal has potential to benefit the ecological interest features of the waterway. To ensure that potentially adverse effects are avoided or minimised and that the potential for ecological enhancement is maximised, restoration should include the following key principles:

- Phased restoration would be preferable for nature conservation (a suggested option is presented in Figure 2) in order to allow application of restoration methodologies appropriate to the receptors present in any particular section.
- Establish inline and offline reserves as habitat enhancement features and secure areas for key species e.g. grasswack pondweed.
- Channel to be restored to variable width reflect receptor sensitivity e.g. 10 m width for aquatic macrophyte species and 5 m width for common reed.
- Restore sections adjacent to sensitive receptors before restoring receptor sections e.g. Grasswack pondweed is found between Bottesford Wharfe and Stenwith so restoration of Redmile to Bottesford Wharfe would be a priority.
- Dredging profiles and engineering designs to be suitable for maintaining the ecological interest of the waterway e.g. use of soft bank protection options such as coir rolls planted with locally appropriate native emergent vegetation species of UK or preferably local provenance.
- Species translocations to be undertaken as appropriate to increase abundance and distribution of key aquatic macrophytes and emergent vegetation.
- Sufficient time must be left following restoration works in order to allow aquatic communities time to recover prior to navigation and ongoing monitoring will be required to determine when sufficient time has elapsed.
- On completion of restoration a program of boat monitoring and assessment is proposed in conjunction with vegetation monitoring to assess any community change as a result of navigation and appropriate action taken on an iterative basis in consultation with Natural England.

6.1.3 As ecological species and habitats are dynamic receptors further surveys will be required prior commencement of works at individual locations and once detailed designs and programmes for restoration are known. This should include the following surveys:

- Walkthrough survey of sections to be restored – update of 2006 survey and check against 2006 maps.

- Aquatic macrophyte survey, particularly in Harby-Redmile SSSI and adjacent sections.
- Invasive species survey, including presence of water fern and water hyacinth.
- Badger survey.
- Bat survey.
- Surveys for other protected species identified during walkthrough survey including water vole and reptiles

6.1.4 The adoption of a sensitive and variable approach to restoration (as detailed in Section 5,) would have potential to enable the restoration of the Grantham Canal to be undertaken without significant adverse impacts to the ecological species and communities present within the canal corridor. Assuming that the approaches and recommendations proposed within this report are followed no significant adverse impacts to nature conservation are anticipated to result from the restoration as proposed.

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8. Glossary

Aquatic macrophyte	Macrophyte of an aquatic habitat. Does not include filamentous green algae.
Benthic	Bottom of a water column.
Benthiverous	Bottom-feeding species, i.e. one that inhabits the bottom of a water column.
Connectivity	Refers to habitats and species populations; reduced connectivity of habitats subsequently reduces the connectivity of species populations, which is important in maintaining genetic diversity, and reducing risk of population extinction.
Cyprinid	Fish belonging to the Cyprinidae family, which includes species such as Carp.
Eutrophic	Term describing the elevated nutrient status of a habitat; increasing the levels of available nutrients within a habitat alters its characteristics and species composition.
Eutrophication	Process by which a habitat becomes eutrophic.
Fissate	Describing the deeply fissured bark of crack willow (<i>Salix fragilis</i>).
Macrophyte	A vascular plant large enough to be seen with the naked eye.
Receptor	Habitat, species or other ecological feature that has the potential to be impacted upon as a result of the proposed restoration.
Saproxylic	Refers to a group of invertebrates that are dependant on dead wood.



Figure 1. Designated Sites

Figure 2. Proposed Restoration Phases

Figure 3. In-line Reserve Design

Figure 4. Pondweed Turion Translocation.

Figure 5. Bat House Design

Figure 6. Coir Roll Bank Protection

Figure 7: Sample Offline Reserve Design: Pond Style

Figure 8: Sample Offline Reserve Design: Canal Style

Figure 9: Sample Dredging Profiles