Grand Union Canal Transfer

GUC SRO Gate 3 Annex B3.4 INNS Risk Assessment

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AECOM

Grand Union Canal Transfer

Grand Union Canal SRO

Environmental Assessment (Gate 3)
Invasive Non-Native Species (INNS) Risk Assessment

Affinity Water

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1. Introduction

1.1 Context

1.1.1 This report details the assessment of the Invasive Non-Native Species (INNS) assemblage along the Coventry, Oxford and Grand Union Canals for the Grand Union Canal (GUC) transfer scheme. These canals are all connected, and also connect to the rivers Tove, Avon, Nene, and Ouzel. Additionally, header reservoirs are upstream of the canal network, and it is proposed to create a new connection to two of them, Daventry and Drayton Reservoirs, such that they would also be 'downstream' (i.e. a loop will be created, GUC → Reservoirs → GUC). Accordingly, elements of these additional waterways/water bodies form part of the environmental assessment of the GUC and Minworth Strategic Resource Option (SRO) schemes at RAPID[1] Gate 3.

1.1.2 The services to be delivered are for Affinity Water (AfW), Severn Trent (ST), and the Canal and River Trust (the Trust), collectively referred to as the Programme Management Board (PMB). Further detail of the SRO schemes is provided below.

1.1.3 The purpose of the environmental assessments is to assess the GUC SRO (and Minworth SRO) as potential supply-side options within the RAPID Gated process.

1.2 Background

1.2.1 Minworth SRO includes a new Advanced Wastewater Treatment Plant (AWTP) that will treat final effluent from Minworth Wastewater Recycling Centre (WwRC). This flow will then be transferred to the existing canal waterways in the northern section of the GUC route (Coventry Canal → Oxford Canal → GUC). Upgrades to existing canal assets are required to facilitate additional flows and to ensure sufficient freeboard to the canal is maintained. Minworth SRO will be the source of recycled water to support the new abstraction for the GUC SRO. The Minworth SRO was reported separately to the GUC in its own Gate 2 submission, and the risk of INNS being transferred to the canal network from Minworth WwRC is also investigated separately in Gate 3.

1.2.2 In the southern section of the GUC, water will be abstracted from the canal and treated prior to distribution to AfW customers (refer to Figure 1-1 for Scheme Layout) via an underground reservoir near Luton.

1.2.3 The RAPID gated process has allowed these SRO schemes to develop at pace, making significant progress since investigations began in April 2020. Through Gate 2, it was demonstrated that the GUC SRO offers drought resilience to AfW customers and to the GUC by utilising enhanced recycled water.

1.2.4 A key element of the GUC and Minworth SROs is to investigate the environmental risks and opportunities associated with delivery of the schemes. Previous environmental assessments at Gate 1 and Gate 2 have considered Water Framework Directive (WFD) related impacts and benefits, baseline ecological data and in particular the potential impacts of changes in flow to ecological receptors such as designated sites and their qualifying features, protected and notable species, and constraints from the presence or future spread of invasive non-native species (INNS). Gate 2 environmental assessments also informed Biodiversity Net Gain (BNG) and Natural Capital assessments, Habitats Regulations Assessment (HRA) screening, and WFD assessment to support the Environmental Assessment Reports for Gate 2 submission. Environmental assessments at Gate 1 and Gate 2 have been informed by regular engagement with regulators and stakeholders to provide direction and buy-in for the on-going assessments.

[1] The Regulators' Alliance for Progressing Infrastructure Development (RAPID) https://www.ofwat.gov.uk/regulated-companies/rapid/the-rapid-gated-process/

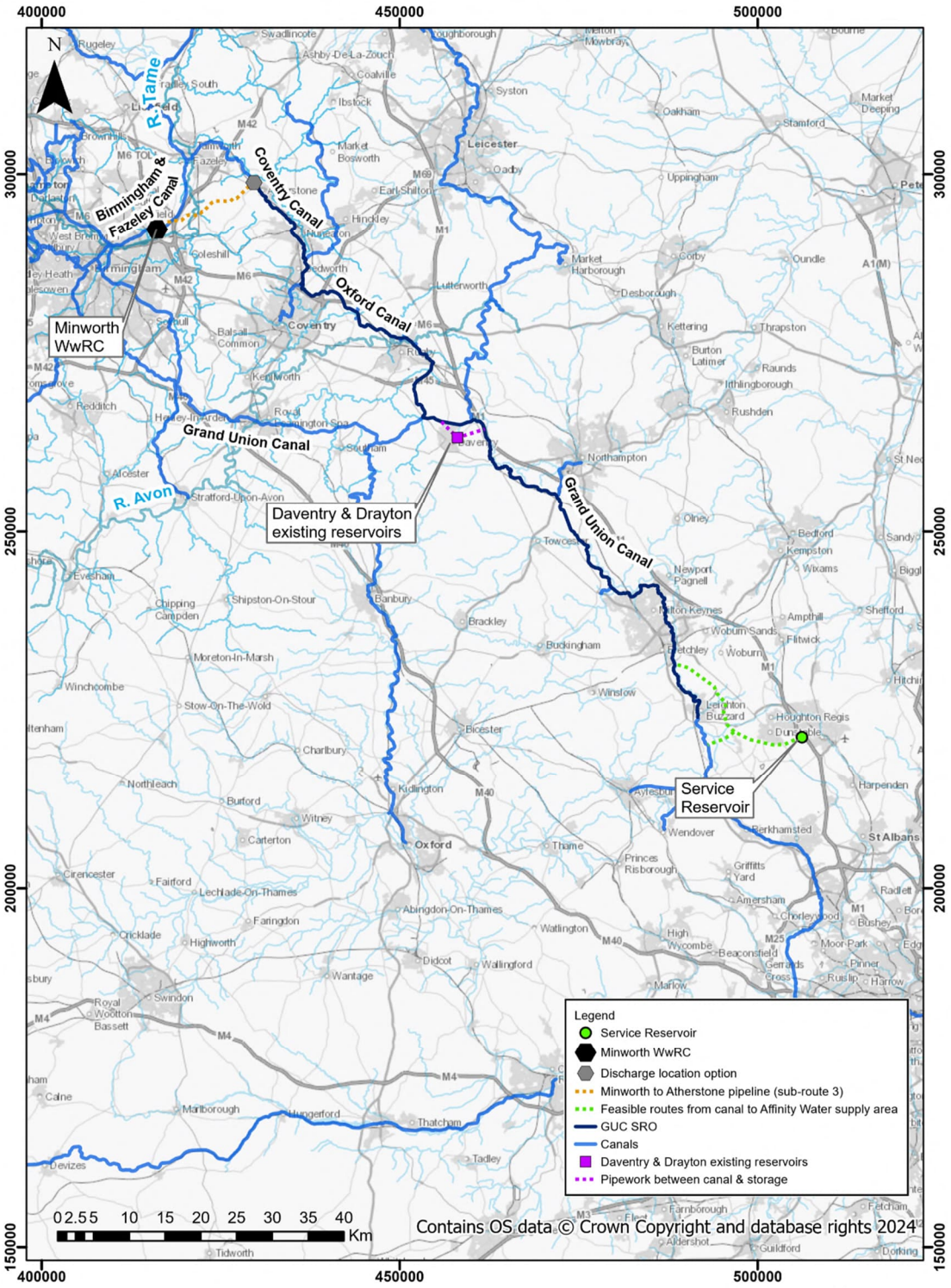

Figure 1-1: Scheme layout (provided by AfW August 2024)

Grand Union Canal (GUC) Strategic Resource Option (SRO)

1.2.5 The draft WRSE (Water Resources South-East) Regional Plan selects the GUC to meet the deployable output requirements of the region by 2032. The Scheme has been sized and costed for the transfer of up to a total of 115 Ml/d (megalitres per day).

1.2.6 The GUC SRO will be designed to accept a maximum of 115 Ml/d from Minworth SRO as per the WRMP24, PR24 and regional water resource planning regulatory submissions. The utilisation of the Scheme will vary over the course of a given year, with expected 80-100% utilisation in the summer months and a lower tick-over flow around 25% of capacity throughout the winter. The 115 Ml/d capacity generates a 100 Ml/d Deployable Output (DO).

1.2.7 GUC is a 'transfer option' and will receive recycled water from Minworth WwRC AWTP to transfer via the canal network (Coventry Canal, Oxford Canal and GUC) to an abstraction location near Bletchley. A new pipeline and existing canal infrastructure will be utilised to convey recycled water from Minworth SRO in Severn Trent's supply area to Affinity Water's supply area. Water will be abstracted from the GUC and treated prior to distribution to customers.

1.2.8 Transferred water will progress along the Coventry Canal by gravity, and into the Oxford Canal at Hawkesbury Junction. Flows will need to bypass Hawkesbury Junction via a low-lift pumping station. The Oxford Canal will then convey the water to the GUC and then on to a pumping station at Braunston Junction, where water will be pumped to Daventry and Drayton Reservoirs (see section below) and also past Braunston Locks on the GUC. The majority of flow along the Oxford Canal will be by gravity; however, a pumping station will be required to bypass the locks at Hillmorton.

1.2.9 A further lock bypass pumping station may be required south of Milton Keynes at Fenny Stratford. The GUC section also requires eight gravity bypasses to "downflow" locks at the Wilton Marine Lock Flight, Stoke Bruerne Lock Flight and Cosgrove Lock.

1.2.10 Bank and towpath raising will be required to accommodate the increase in water levels along the canals and will range from 100 mm up to 250 mm. For a transfer of 115 Ml/d approximately 54 km would require raising out of a total canal length of approximately 120 km from Atherstone to Bletchley. Modifications to 57 existing waste weirs will prevent water loss to adjacent watercourses under all scenarios. Piped bypass arrangements or canal widening will be needed at four hydraulic constraint points to avoid exceeding velocity limitations for canal operation, set at 0.3 m/s to ensure that boat navigation is not hindered. Similarly, it is currently assumed (based on Gate 2 hydraulic modelling for the GUC) that five existing bridges will need to be modified (to maintain head clearance) for the 115 Ml/d Scheme.

1.2.11 As such, with respect to the core hydrological components of the SRO (i.e. the canal network and connected rivers), no new hydrological connections are created. However, there will be modifications to water depth, volume, and flow rate, and resistance to the movement of plants and animals along the network may be affected (e.g. due to lock bypasses). Additionally, new connections will be created with respect to three reservoirs associated with the SRO, Daventry Reservoir, Drayton Reservoir, and Bletchley storage reservoir.

1.2.12 Options for abstracting water from the canal were shortlisted. The current site for abstraction and treatment is Bletchley Water Treatment Works, with a transfer route to the AfW supply network via an underground reservoir near Luton. Criteria for selection included site constraints, energy efficiency, environmental risk, carbon emissions, cost, and social and environmental benefits.

Daventry Reservoir and Drayton Reservoir

1.2.13 In order to regulate water levels in the Grand Union Canal at times of unusually low rainfall and to compensate for water lost through the operation of locks, various reservoirs were created. Initially, the summit of the canal was fed by a small reservoir at Braunston. However, this was quickly supplemented by Drayton Reservoir (also known as the Old Daventry Reservoir), which was built to the north-west of Daventry town. Subsequently, a site was identified on the north-eastern outskirts of Daventry for the New Daventry Reservoir, which was in use by 1804 and is now known as Daventry Reservoir.

1.2.14 Drayton Reservoir and Daventry Reservoir currently operate as header reservoirs for the GUC and are operated by the Trust. These reservoirs are near to each other (being approximately 1 km apart) and are located approximately 40 km from Atherstone and 44 km from Bletchley 'as the crow flies.'

1.2.15 The current proposal consists of transfer from the GUC at Braunston into the upstream end of both reservoirs, as shown in Figure 1-2. This would create two new pathways from the Grand Union Canal into Drayton and Daventry Reservoirs. The reservoirs are proposed as a 'Storage Option' to support the GUC transfer, whereby the reservoirs can be drawn down to augment the transfer in the GUC during periods of high demand, or as dictated by hands-off flows in the River Trent. During such eventuality, continued transfer from Minworth to the River Tame may be required to support flows in the River Trent, and therefore the GUC transfer in the canals will be augmented by transfer from the reservoirs. It is proposed that a semi-continuous transfer of 28 Ml/d from the GUC to the reservoirs will be maintained to ensure they are full to provide draw-down support as and when required.

1.2.16 Water would then be drawn-down from the reservoirs to the GUC via existing connections to the GUC to the northeast of the reservoirs. It is currently assumed that fluctuations in reservoir levels will remain within current ranges, with maximum water levels controlled by reservoir restrictions, and a current draw-down limit of 30% capacity on Drayton Reservoir due to angling and recreational activities.

1.2.17 As a result, this will result in the two reservoirs becoming both 'downstream' and 'upstream' of the GUC. Additionally, while additional waterways are downstream of these reservoirs, these latter waterways (i.e., the headwaters of the River Nene catchment) are also already downstream of the GUC. As such, the only significant change in hydrological connectivity, and thus, INNS risk, is the creation of the new links from the GUC to the reservoirs, and the potential onward transfer of INNS.

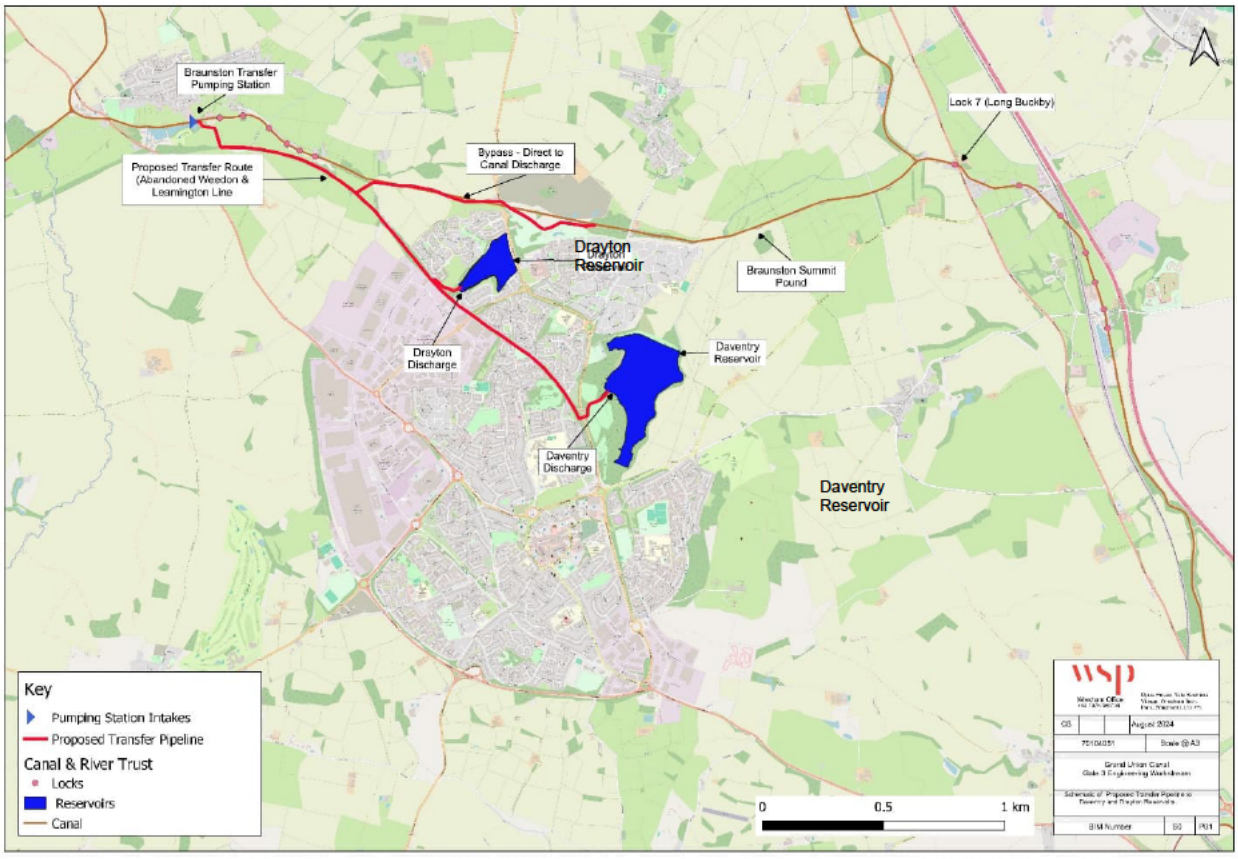

Figure 1-2: Schematic of currently proposed transfer pipeline to Daventry and Drayton Reservoirs

Minworth SRO

1.2.18 Minworth SRO is one of several SROs currently being considered under the RAPID gated process. The Scheme is under consideration as part of a portfolio of solutions to ensure that a reliable and resilient water supply is provided to water-stressed areas in England; in particular, the south-east of England.

1.2.19 Minworth SRO is a 'source option', providing up to 115 Ml/d via GUC. Minworth SRO also includes the option to transfer an additional 115 Ml/d to support the Severn to Thames Transfer (STT) SRO, and therefore assessment through Gate 1, Gate 2, and Gate 3 has considered the in-combination impacts on the River Tame and Trent system of Minworth supporting both GUC and STT (230 Ml/d combined). Minworth SRO provides a source of recycled water to STT SRO, GUC SRO, or both.

1.3 Assessment of INNS

1.3.1 Through defining the scope of the Gate 3 environmental assessments to date, we have considered the environmental assessments completed for the SRO schemes at Gate 1 and Gate 2, the outcomes of these assessments, comments from regulators and assurance processes and any recommendations for further work. This understanding of the background for the Minworth and GUC SROs forms the basis of the Gate 3 monitoring and assessment programme.

1.3.2 This report details the assessment of the invasive non-native (INN) assemblage of plants and animals along the water transfer route. Recommendations and mitigation strategies are also presented in Section 5 of this report.

1.3.3 The objectives of the INNS assessment presented in this report were to:

- investigate records of INNS from background data research;
- survey the canals, connecting rivers (at the point of connection) and reservoirs within the zone of influence of the Scheme for INNS to ascertain current species assemblages;
- complete a qualitative risk assessment to ascertain any potential impacts the Scheme may have on the current INNS assemblage; and
- provide recommendations, where necessary, for the mitigation of any INNS receptors.

1.3.4 It was agreed with the Environment Agency that the SRO Aquatic INNS Risk Assessment Tool (SAI-RAT) would not be used at Gate 3 as the tool remained in development and Beta testing. This tool will be utilised at Gate 4 to further inform the INNS pathways risk assessment.

Rationale for Gate 3 Assessment

1.3.5 This component of the Gate 3 environmental assessment is justified following consideration of the potential impacts of the Scheme, which are summarised in Table 1-1 below. Further detail is also provided in Section 1.3.2.2.

Table 1-1: Potential impacts of the GUC and/or Minworth SRO on INNS

Potential impact	Impact pathway	Rationale for assessment
Increased rate of spread of INNS along the canal network and, consequently, the rate of spread to connected water bodies/waterways. INNS can result in negative environmental and economic impacts and facilitating the spread of INNS can result in breaches of legislation.	Increased water volume, depth, and flow rate, in the canal network, potentially more readily facilitating the movement of INNS.	INNS have been identified in the canal network, many of which spread by waterflow.
	New bypasses (e.g. of locks), potentially reducing resistance to INNS spread along the canal network.	Locks, and/or other canal features, will be bypassed, e.g. using pumping stations at Hawkesbury, Hillmorton, Fenny Stratford, Stoke Hammond, Three Locks, and Leighton, and using gravity bypasses at Wilton, Stoke Bruerne, and Cosgrove.
Facilitating the spread of INNS to new locations within the canal network.	Increased water volume, depth, and flow rate in the canal network, potentially allowing INNS to reach new locations and/or making parts of the network more suitable to INNS.	INNS have been identified in the canal network, many of which grow in water, spread in water, or spread by waterflow.

Spread of INNS to new locations, that were previously unconnected or 'upstream' of the canal network.	Creation of new water routes.	New pipes will be installed and used to pump water to Drayton and Daventry Reservoirs from the GUC (which will be used for water storage). These reservoirs were previously upstream of the GUC (see Section 1.2.X for details).

Current Pathways and the Rationale for Assessment

1.3.6 Were they to be created, new pathways between the three canals (Coventry, Oxford, and Grand Union) and the four rivers (Tove, Avon, Nene, and Ouzel) could aid in the spread of INNS between the three canal systems. However, these six watercourses are already completely hydrologically linked through existing and very long-established pathways. The Scheme will not need to create new connections between these waterways; however, there will be modifications to water depth, volume, and flow rate, and resistance to the movement of plants and animals along the network may be affected (e.g. due to lock bypasses). As such, INNS surveys are necessary in order to examine the current assemblage of INNS species present in the canals and rivers, so that INNS risk, even if it is low, can be identified and assessed.

1.3.7 Additionally, in the Scheme, the Daventry and Drayton Reservoirs are proposed as a storage option to support the water transfer (see Section 1.2.3). The current proposal consists of a bi-directional transfer from the GUC into the upstream end of both reservoirs (Figure 1-2). Therefore, the Scheme will be creating a new pathway from the GUC into the reservoirs thus creating a potential risk for the spread of INNS into the reservoirs. Invasive non-native species were surveyed in these two reservoirs to inform this assessment.

Stakeholder Engagement

1.3.8 The scope of assessment is also informed by on-going regulator and stakeholder engagement, both through Gate 1 and Gate 2, and through developing the scope for Gate 3 assessment. Regulator and stakeholder comments relevant to this assessment are summarised in Table 1-2 below, with responses in relation to the rationale for assessment.

Table 1-2: Regulator and stakeholder comments and rationale for assessment scope

Regulator/Stakeholder	Source	Comment	Response and rationale for assessment
RAPID	GUC Gate 2 Final Decision	*Continue to investigate areas of INNS risk. Engage with the Environment Agency on scope for this work. Provide evidence to confirm treatment process will eliminate INNS from discharge into canal.*	INNS surveys have been completed as part of the Gate 3 aquatic ecology surveys. Liaison with the Minworth engineering design team will establish the risk of transfer of INNS from Minworth WwRC, which has been assessed in the Gate 3 INNS risk assessment within this report. Also refer to the INNS Risk Assessment Report for Minworth SRO.
Environment Agency	GUC EA Combined Comments Log	*The potential transfer of INNS by recreational activity from narrow boats, canoeists, and fisherman and from CRT canal operations needs to be appropriately considered. This presents a potential pathway south of the abstraction point. The key would be best practice by all users and ongoing monitoring.*	This has been considered during the Gate 3 INNS risk assessment within this report.
Environment Agency	GUC EA Combined Comments Log	*Could you please explain why the new storage reservoir is risk assessed as low risk? If you are creating a new WB and filling it with water which has a high INNS load, surely the source to receptor transfer risk is high?*	As part of the Gate 3 INNS risk assessment, the RA tool has not been used. A qualitative review of the risk of INNS spreading into the storage reservoirs has been made in this report which has updated the risk level. The location of the southern storage reservoir post-abstraction from the GUC at Bletchley has been assessed.

Regulator/Stakeholder	Source	Comment	Response and rationale for assessment
Environment Agency	GUC EA Combined Comments Log	*INNS surveys state they will be targeted and have a sampling point at each connected water body. The grid refs supplied via email do not have any location on the Tove.*	The River Tove has been re-surveyed for INNS at Gate 3, and this has fed into the Gate 3 INNS risk assessment.
Environment Agency	GUC EA Combined Comments Log	*Connections to the Tove, re-assurance that INNS transfer has been fully investigated in this area.*	The River Tove has been re-surveyed for INNS at Gate 3, and this has fed into the Gate 3 INNS risk assessment.
Environment Agency	GUC EA Combined Comments Log	*Given the timescales for the survey work, how likely is it that field survey for macrophyte INNS will be effective?*	Gate 3 aquatic ecology surveys have been completed in the optimal survey seasons: May for macroinvertebrates; July for macrophytes.
Environment Agency	GUC EA Combined Comments Log	*It says that eDNA surveys may be updated for the later stages of the assessment (including the EIA)'. Could the same be done for macrophyte INNS since they will not be assessed fully at this stage due to the time constraints.*	Gate 3 surveys will inform the EIA, and recommendations for further or update surveys will be made as appropriate. Detailed macrophyte surveys have been completed alongside Canal PSYM at Gate 3.
Environment Agency	Gate 3 scope EA combined comments	*Mink survey - what is the purpose of the mink survey? It would be far more beneficial to engage with the Countryside Restoration Trust mink programme and trap and remove mink.*	Mink surveys have been completed through incidental records observed during Water Vole (*Arvicola amphibius*) surveys and informed by the detailed ecological desk study. We will liaise with the Canal and River Trust and other stakeholders to inform the assessment, including to add to the database of mink records. Supporting mink control would involve specific licensing and resourcing, which may already be in place through the Canal and River Trust programme. This is discussed further in the recommendations section of this report.
Environment Agency	Gate 3 scope EA combined comments	*These are not the current locations for the INNS assessments. Please update the table accordingly., which will provide a more comprehensive location list and allow for direct comparison with G2 results.*	Locations for INNS and canal PSYM surveys have provided within this report.
Environment Agency	Gate 3 scope EA combined comments	*Agree with LS comment that surveying for mink should just be changed to control of mink. Mink are present so let's take opportunity to remove an invasive and use the trap data to show where the concentrations are present. same effort required for mink monitoring as is for mink control so let's get a positive result from all this assessment work.*	We will liaise with the Canal and River Trust and other stakeholders to inform the assessment, including to add to the database of mink records. Supporting mink control would involve specific licensing and resourcing, which may already be in place through the Canal and River Trust programme. This is discussed further in the recommendations section of this report.

2. Scope and Approach

2.1 Projects and Work Completed to Date

2.1.1 The following assessments were completed at Gate 1 and Gate 2 and have informed the scope of continuing assessment at Gate 3:

- GUC SRO Gate 1 Submission, with results of:
  - fish survey and habitat walkover; and
  - reporting of invasive non-native species observed during the above surveys.
- GUC SRO Gate 2 Annex B2 – Ecological Monitoring: Phase 2 Report, with results of:
  - continuation of CPET monitoring;
  - invasive non-native species monitoring; and
  - macrophyte monitoring of chalk streams associated with the GUC.

2.2 Legislation

2.2.1 Refer to Appendix B for further detail of INNS legislation in the context of this assessment.

Wildlife and Countryside Act 1981 (Schedule 9)

2.2.2 The Wildlife and Countryside Act (the WCA) [2] is a primary piece of UK wildlife legislation and defines a list of INNS. This Act makes it illegal to release or allow to escape into the wild any listed INN animals, or to cause to grow in the wild any listed INNS plants.

Invasive Alien Species (Enforcement and Permitting) Order 2019

2.2.3 The Invasive Alien Species (Enforcement and Permitting) Order 2019 (the IAS Order)[3] came into effect on 1 October 2019. This implemented the EU Invasive Alien Species Regulation 1143/2014[4] on the prevention and management of invasive alien plant and animal species in England and Wales, including the relevant licenses, permits and rules for keeping invasive alien species.

2.2.4 The provisions of this Order will be taken account within the assessment by ensuring INNS of special concern potentially affected by the Scheme are considered. If it is not a species of special concern, then the WCA (Section 14, Schedule 9) still applies.

Water Environment Regulations and the Water Framework Directive (WFD)

2.2.5 Whilst not directly relevant to the invasive non-native species assessment, increased spread of these species has the potential to cause the WFD status of watercourses to be affected. As a result, invasive non-native species are an important consideration in the WFD assessment process.

2.3 Method

2.3.1 To satisfy the objectives stated above (Section 1.3), this report combines the INNS data recorded from:

- desk study data for INNS potentially relevant to the Scheme;
- aquatic macroinvertebrate surveys of the canals and reservoirs within the zone of influence of the Scheme using canal Predictive System for Multimetrics (PSYM) methodology;

[2] https://www.legislation.gov.uk/ukpga/1981/69
[3] https://www.legislation.gov.uk/uksi/2019/527/contents/made
[4] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32014R1143

- aquatic macrophyte surveys of all canals, connecting rivers (at the point of connection) and reservoirs within the zone of influence of the Scheme ;
- fish habitat surveys for all canals within the zone of influence of the Scheme;
- results of analysis of waters samples for eDNA for a range of INNS for all canals, connecting rivers (at the point of connection) and reservoirs within the zone of influence of the Scheme; and
- riparian mammal surveys of the canals forming the transfer scheme.

2.3.2 INNS recorded from the surveys mentioned above are included in this report along with records obtained through the desk study. There is a separate Aquatic Ecology Report, Fish Habitat Assessment Report, Water Vole Survey Report, and Daventry and Drayton Reservoirs Aquatic Ecology Report, that contain the full results from these surveys.

2.3.3 The review of potential impacts to Daventry and Drayton Reservoirs was informed by:

- INNS in the Grand Union Canal that could be spread into one or both reservoirs;
- INNS already in the reservoirs;
- existing hydrological connectivity;
- the feasibility of eradicating or substantially reducing the occurrence and abundance of species which would be new to either or both reservoirs in the section of canal from which the water will be abstracted;
- identifying those INNS, e.g. fish, unable to survive passing through the pump(s) used to transfer water to the reservoirs;
- identifying those residual species for which there is a risk that they will be spread into one or both reservoirs, in which case each species needs to be assessed to determine:
  - what impact would the species have on the reservoirs and associated activities, e.g. angling?
  - what is the likelihood that a species would be spread into the reservoirs anyway in the fullness of time, i.e. over the next decade?
- assuming that the reservoirs are under surveillance for invasive non-native species as part of the water transfer scheme, could an established ‘rapid response’ procedure be implemented should a species of concern be found to have been transferred?

Desk Study

2.3.4 A desk study was carried out to identify records of invasive non-native species potentially relevant to the proposed Scheme.

2.3.5 Records of invasive non-native species from the Bedfordshire, Buckinghamshire and Milton Keynes, Birmingham, Leicestershire and Rutland, Northamptonshire, and Warwickshire Local Environmental Centres (LERCs) were requested within 2 km of the various water bodies from the last 10 years. For aquatic macrophytes and aquatic macroinvertebrates, records from locations and habitats which were not hydrologically connected to the Scheme were not considered within this report.

2.3.6 Environment Agency ecological survey data within a 2 km radius of the survey area from the last 10 years were reviewed using the Environment Agency Ecology and Fish Data Explorer[5]. Records of macrophytes, aquatic macroinvertebrates and fish from locations and habitats not hydrologically connected to the Scheme were not considered within this report.

2.3.7 Relevant results from ecological monitoring, including CPET and invasive non-native species surveys[6] are included in this report. The locations of the sites surveyed for CPET and invasive non-native species are presented in Table 2-1. Note that six of the sites surveyed for CPET in Gates 1 and 2 are in identical

[5] https://environment.data.gov.uk/ecology/explorer/
[6] GUC Gate 2 Annex B2 Ecological Monitoring. Report to Affinity Water by Stantec and Apem.
GUC Gate 2 Annex B3.2.4 INNS Risk Assessment Report. Report to Affinity Water by Mott MacDonald.

locations to sites surveyed by AECOM in 2023 (see also Table 2-2), while two sites within the Scheme surveyed for invasive non-native species in Gates 1 and 2 were not surveyed by AECOM in 2023.

2.3.8 Information from representatives of the Canal and River Trust was also considered during this assessment but it should be noted that the information was anecdotal evidence from angling groups.

2.3.9 To achieve a more holistic understanding of the assemblage of invasive non-native species along the water transfer route, other sources of information such as the journals of the natural history societies of the overall survey area were also used. These information sources can be found in Appendix B along with comments on how they were used.

Table 2-1: Locations of CPET and invasive non-native species surveys from Gate 1 and Gate 2 ecological monitoring

Pound	Gate 3 Site ID	Gate 2 site ID	Location	National Grid Reference	CPET 2020	CPET 2021	INNS
OX 2-1	OC-03	3	Oxford Canal near River Avon crossing		-	-	Y
CC 7-8	CC-01	CP-04	Coventry Canal, Atherstone		Y	Y	Y
GU 6-7	GUC-01	CP-08	GUC, Welton Lane, Daventry		Y	Y	-
INT 8-13	GUC-02	CP-09	GUC, Long Buckby Wharf		Y	Y	-
INT 13-14	GUC-04	4	GUC and Northampton Arm at Gayton Junction		-	-	Y
INT 14-20	GUC-05	CP-13	GUC, Stoke Bruerne		-	Y	Y
INT 14-20	-	IN-04	GUC near River Ouzel		-	-	Y
GU 23-24	GUC-08	CP-14	GUC, Three Locks		-	Y	-
GU 23-24	-	IN-05	GUC near River Tove		-	-	Y
GU 27-28	GUC-09	8	GUC near River Ouzel connection		-	-	Y
INT 2-7	OC-04	CP-04a	Oxford Canal, Willoughby		Y	Y	-
-	AVON	River Avon	-		-	-	Y
-	OUZEL	River Ouzel	-		-	-	Y
-	TOVE	River Tove	-		-	-	Y

Field Surveys

2.3.10 A brief summary of the different methods used to collect the data analysed in this report is provided in the following sections. For full details on each method, please refer the following reports:

- Aquatic Ecology Report for macrophytes, macroinvertebrate and eDNA surveys on the canals and connected rivers;
- Fish Habitat Assessment Report for fish habitat assessment and eDNA surveys on the canals;
- Water Vole Survey Report for riparian mammal surveys on the canals; and
- Daventry and Drayton Reservoirs Aquatic Ecology Report for macrophytes, macroinvertebrate and eDNA surveys on Drayton and Daventry Reservoirs.

2.3.11 All surveys and laboratory analyses were completed by suitably experienced aquatic and terrestrial ecologist and/or suitably experience lab technicians.

Macrophyte and Macroinvertebrate Surveys – Canals and Rivers

2.3.12 The survey dates and locations of the macrophyte and macroinvertebrate surveys along the canals and rivers are presented in Table 2-2. The canal locations surveyed expand upon sites surveyed previously in Gate 1 and Gate 2, whilst scoping out sites from Gate 2 that are no longer considered for the Scheme. Additional sites have been selected to provide representative coverage of the proposed Gate 3 route.

2.3.13 Engagement with the Environment Agency emphasised the canal reaches that are close to or in direct contact with rivers were of greatest concern. Three rivers (the River Avon, River Ouzel and River Tove) are hydrologically connected to the canals and therefore, canal sites close to their connections have been chosen. The River Nene was not surveyed as it is more distantly connected via Drayton and Daventry Reservoirs. Note that macroinvertebrate canal PYSM surveys were not conducted on the rivers, as this methodology is only applicable to standing waters.

2.3.14 Aquatic macroinvertebrates were sampled from each canal location using the canal PSYM method developed by the Freshwater Habitat Trust[7] and dredge throws. The samples were sorted and analysed in a laboratory setting which consisted of canal PSYM, Community Conservation Index (CCI)[8] and Whalley, Hawkes, Paisley, and Trigg (WHPT) Index[9].

2.3.15 Macrophyte surveys were carried out over a 300-400m reach centred on the national grid reference (see Table 2-2). Some flexibility was given to the survey lengths due to the patchy distribution of macrophytes on the canals. For example, where stands of macrophytes were observed falling just outside of the survey length which had previously not been identified, the survey reach was extended in that direction to encompass them. Macrophyte abundances were estimated using the Taxon Cover Value (TCV) method, using a nine-point cover scale.

Table 2-2: Macrophyte and aquatic macroinvertebrate survey locations and dates

Pound	Site ID	Site Name	National grid reference	Macrophyte survey	Macroinvertebrate survey
CC 7-8	CC-01	Coventry Canal, Atherstone		06/07/2023	17/05/2023
CC 1-1	CC-02	Coventry Canal, Nuneaton		06/07/2023	17/05/2023
	CC-03	Coventry Canal/Ashby Canal at Marston Junction		06/07/2023	16/05/2023
	CC-04	Coventry Canal/Oxford Canal at Hawkesbury Junction		06/07/2023	11/05/2023
GU 6-7	GUC-01	GUC, Welton Lane, Daventry		05/07/2023	10/05/2023
INT 8-13	GUC-02	GUC, Long Buckby Wharf		04/07/2023	10/05/2023
GU 13-14	GUC-03	GUC, Heyford Lane		04/07/2023	10/05/2023
	GUC-04	GUC and Northampton Arm at Gayton Junction		04/07/2023	10/05/2023
INT 14-20	GUC-05	GUC, Stoke Bruerne		04/07/2023	11/05/2023
GU 20-21	GUC-06	GUC, Thrupp Wharf		04/07/2023	11/05/2023
GU 21-22	GUC-07	GUC, Milton Keynes		03/07/2023	09/05/2023
GU 23-24	GUC-08	GUC, Three Locks		03/07/2023	09/05/2023
GU 27-28	GUC-09	GUC near River Ouzel connection		04/07/2023	09/05/2023
OX 2-1	OC-01	Oxford Canal, Cathiron Lane		06/07/2023	16/05/2023

[7] Pond Action. (2002) A guide to monitoring the ecological quality of ponds and canals using PSYM.
[8] Chadd, R. & Extence, C. (2004) The conservation of freshwater macroinvertebrate populations: a community-based classification scheme. Aquatic Conservation: Marine and Freshwater Ecosystems 14: 597-624.
[9] WFD-UKTAG. (2021) UKTAG River Assessment Method Benthic Invertebrate Fauna: Invertebrates (General Degradation): Whalley, Hawkes, Paisley & Trigg (WHPT) metric in River Invertebrate Classification Tool (RICT). Water Framework Directive - United Kingdom Advisory Group, Stirling, UK.

Pound	Site ID	Site Name	National grid reference	Macrophyte survey	Macroinvertebrate survey
	OC-02	Oxford Canal and Rugby Arm at Rugby	[redacted]	06/07/2023	15/05/2023
	OC-03	Oxford Canal near River Avon crossing		05/07/2023	15/05/2023
INT 2-7	OC-04	Oxford Canal, Willoughby		03/07/2023	16/05/2023
	OC-05	Oxford Canal/GUC at Braunston Junction		05/07/2023	15/05/2023
-	AVON	River Avon		05/07/2023	-
-	OUZEL	River Ouzel		03/07/2023	-
-	TOVE	River Tove		04/07/2023	-

Macrophyte and Aquatic Macroinvertebrate Surveys – Reservoirs

2.3.16 The macrophyte surveys were undertaken and data analyses were completed using the Lake LEAFPACS2 method[10]. This has been designed to detect nutrient enrichment in lakes by analysis of the macrophyte community and provide metrics indicating the level of eutrophication present. The surveys were carried out on the 24th and 25th of August 2023 by two experienced aquatic ecologists and conformed to CEN 15460:2007 Water quality – Guidance standard for the surveying of macrophytes in lakes[11]. The survey took place when the reservoirs were at normal levels, during good weather conditions. In addition to the standard Lake LEAFPACS2 surveys, the surveyors walked as much of the perimeter of the reservoirs as practicable to identify any macrophyte species not identified in Lake LEAFPACS2 transects.

2.3.17 The survey locations of the aquatic macroinvertebrate samples from the reservoirs are presented in Table 2-3. Macroinvertebrate survey methodology followed the UK-TAG Lake methodology (WFD-UKTAG, 2008[12]). The surveys were completed on 24 August and 06 September 2023.

Table 2-3: Locations of macroinvertebrate surveys at Daventry and Drayton Reservoirs

Site	Survey Location
Daventry Northeast Corner	SP 58206 63798
Daventry Café Corner	SP 57812 64194
Daventry Bird Hide	SP 58058 63536
Daventry Reedbed	SP 57723 63833
Drayton Car Park	SP 56906 64851
Drayton West Boardwalk	SP 56652 64644
Drayton Fish Club Boardwalk	SP 56557 64723

eDNA Surveys – Canals and Rivers

2.3.18 The eDNA sampling method employed was informed by NatureMetrics guidance[13]. Three sampling locations (i.e., upstream, mid-section, downstream) were identified at each canal. For each of these locations, subsamples were taken to increase the probability of detection rates. Table 2-4 summarises the sampling locations for collecting water samples used for eDNA analysis of aquatic

[10] WFD-UKTAG. (2014) UKTAG Lake Assessment Methods - Macrophyte and Phytobenthos: Macrophytes.
[11] European Committee for Standardization. (2007) *CEN 15460:2007 Water quality – Guidance standard for the surveying of macrophytes in lakes*. Brussels: CEN.
[12] WFD-UKTAG, 2008. Lake Acidification Macroinvertebrate Metric (LAMM). [Online] Available at: https://www.wfduk.org
[13] https://www.naturemetrics.com/protocols/advice-note-sampling-strategies-for-aquatic-environments

macroinvertebrates (bivalves and crayfish only), fish, and riparian mammals. eDNA surveys of the River Avon, Ouzel and Tove close to the canal connections were also carried out.

2.3.19 All subsamples were pooled together, thoroughly mixed, and immediately filtered to extract the eDNA. The filtered sample was then preserved with a lysis solution *in-situ* to maintain DNA integrity at ambient temperatures until the DNA could be abstracted for laboratory analysis.

2.3.20 The laboratory analysis was undertaken by NatureMetrics (see Aquatic Ecology Report for summary of the laboratory methodology).

Table 2-4: Locations of the canal and river eDNA sampling sites and their location in relation to canal pound nomenclature

Canal/River	Site ID	CRT Pound	Site NGR
Coventry	CC-01	CC 7-8	[redacted]
	CC-02	CC 1-1	
	CC-03	CC 1-1	
	CC-04	CC 1-1	
Oxford	OC-01	OX 2-1	
	OC-02	OX 2-1	
	OC-03	OX 2-1	
	OC-04	INT 2-7	
	OC-05	INT 2-7	
Grand Union	GUC-01	GU 6-7	
	GUC-02	INT 8-13	
	GUC-03	GU 13-14	
	GUC-04	GU 13-14	
	GUC-05	INT 14-20	
	GUC-06	GU 20-21	
	GUC-07	GU 21-22	
	GUC-08	GU 23-24	
	GUC-09	GU 27-28	
River Avon	AVON	-	
River Ouzel	OUZEL	-	
River Tove	TOVE	-	

eDNA Surveys – Reservoirs

2.3.21 The methods used for water sampling and eDNA analysis at the reservoirs were the same as the ones used along the canals and rivers. The eDNA samples from the reservoirs were collected on the 24th and 25th of August 2023 and at each reservoir, two eDNA samples were collected from the water bodies at different locations. The locations where the samples were taken are presented in Table 2-5.

Table 2-5: Locations of eDNA surveys at Daventry and Drayton Reservoirs

Site	Survey Location
Drayton Car Park	[redacted]
Drayton Fish Club Boardwalk	

Grid references redacted

Site	Survey Location
Daventry Café Corner	[redacted]
Daventry Reedbed	

Fish Habitat Surveys

2.3.22 The fish habitat surveys were originally performed at 18 locations within the extent of the Scheme (between the Atherstone discharge to the Bletchley abstraction point). Following on from the original suite of fish habitat assessments, an additional 89 survey locations were identified from aerial photography. Refer to the Gate 3 GUC Fisheries assessment report (Annex B3.3) for further details.

2.3.23 The majority of the surveys were completed by boat to cover the canal network between survey points to note additional suitable habitat for fish. Any invasive non-native fish found during these surveys were noted.

Riparian Mammal Surveys

2.3.24 The area surveyed for riparian mammals comprised sections of the Coventry Canal, Oxford Canal and GUC that had been identified as being subject to bank raising or water level changes exceeding 0.15 m from the Gate 2 engineering hydraulic modelling reports. Sections of watercourses which were not part of the proposed route but were adjoined to the affected canals were also included in the survey area (up to 100 m from the route). These included the Ashby Canal at Marston Junction, an extension of the Coventry Canal at Hawkesbury Junction, and an extension of the Oxford Canal at Braunston Junction.

2.3.25 Any field signs of American Mink, such as scat, footprints and feeding remains, were noted during the Water Vole (*Arvicola amphibius*) presence/likely absence surveys.

2.4 Limitations

Aquatic Macroinvertebrate Surveys – Canals and Rivers

2.4.1 Access to offside banks of canals to sweep net aquatic macroinvertebrates was largely not possible, so sweep netting and dredge sampling was performed from the towpath banks only. As the offside banks are typically where most emergent vegetation was present, it is likely that some species that are associated with emergent vegetation may have been missed in some samples. With access to offside banks limited, it is possible that smaller/younger and less conspicuous macrophytes growing on the offside banks may have missed detection during surveys.

eDNA Analysis – Canals and Rivers

2.4.2 eDNA results were null for all aquatic macroinvertebrate species at GUC-04. This appears to be an anomaly, as it is the only site on the GUC where this occurred. The anomaly is compounded by the fact that GUC-04 was covered by other ecological surveys (e.g., the fish surveys). Furthermore, aquatic macroinvertebrate species that the eDNA analysis were primed for were physically sampled at GUC-04 in the aquatic macroinvertebrate collection. It is therefore likely that there were errors made in the collection or analysis of that sample.

2.4.3 eDNA analysis did not indicate the presence of any bivalves in the River Tove or River Avon sites but it did identify nine species (including zebra mussel and eight native bivalve species) in the River Ouzel. Macroinvertebrate samples were not collected for the river sites, so data are not available to corroborate eDNA evidence for the River Tove and Avon. However, previous surveys by the Environment Agency in the last 10 years found a number of pea clam (*Pisidium*) species in these rivers not identified in the eDNA survey, so it is possible that processing errors occurred.

Fish Habitat Surveys – Canals and Rivers

2.4.4 Some areas of the three canals were inaccessible by boat as canal rules deemed the Mercury boat used too small for safe passage in locks. Therefore, areas with lots of locks were not surveyed by boat and so some invasive non-native fish species may have been missed during the fish habitat surveys.

This did not have a negative effect on the overall assessment of the invasive non-native fish assemblage along the water transfer route as these areas have been covered by the other surveys mentioned in this report.

Riparian Mammal Surveys – Canals and Rivers

2.4.5 Heavy rain in the preceding days before or during surveys may wash away field signs or cause them to deteriorate, reducing opportunities to record positive signs of riparian mammal presence. Rain during surveys on two of the surveying days was not heavy enough to affect the presence or quality of field signs. The dry periods of 24 h to 48 h after rain before surveys on four of the survey days provided sufficient duration for riparian mammal evidence to be deposited and identified, if it were present.

2.4.6 The presence of dense vegetation in the summer months poses a constraint to surveyors as field signs can be missed. Sections of each water body had thick reedbeds or dense bramble, which prevented access to the banks in these areas and field signs may be missed. The surveys included evidence of American Mink. It is recognised that this was not a detailed survey of the species which would have necessitate deploying monitoring rafts on the banks of the canal. Early scoping that the Scheme will have a neutral impact on Mink. Data on Mink were collected to assist with respect to the Water Vole assessment.

Reservoir Surveys

2.4.7 Deep silt substrates at the southern extent of Daventry Reservoir prevented wading for the LEAFPACS macrophyte surveys. As such, for safety reasons, the wader survey at the Daventry Reedbed site was undertaken from a boat. The deep silt also prevented a macroinvertebrate sample from being taken from shoreside at this site, so this was also conducted from a boat.

2.4.8 Turbidity was a limitation at Drayton Reservoir during the macrophyte survey. In the deeper water wader transects at Drayton Boardwalk, movement of the bathyscope stirred the substrate limiting visibility of macrophytes. This is a common issue affecting Lake LEAFPACS wader transects.

2.4.9 Ideally a fourth LEAFPACS2 sector located along the western shore at Drayton Reservoir would have been undertaken. However, a wide boardwalk running the length of this shore precluded wader transects. All macrophytes growing behind and in front of the boardwalk were identified and recorded. Hence, this was not a significant constraint to the surveys.

3. Results

3.1 Desk Study

3.1.1 Overall, the desk study returned 177 records of 22 invasive non-native species, with the most recent record being from 2021. This was of American Signal Crayfish. Table 3-1 summarises the invasive non-native records returned from the LERCs from the past 10 years. Where English legislation applies to a species, this is shown, with 'WCA Sch9' indicating Schedule 9 of the Wildlife and Countryside Act 1981 (as amended) and 'IAS 2019' indicating the Invasive Alien Species (Enforcement and Permitting) Order 2019.

3.1.2 There were records of one mammal, one crustacean invertebrate and 20 plant species – refer to Appendix A for figures illustrating the distribution of INNS records in the study area.

Table 3-1: INNS identified within the canal system or within 2 km of the study area from the last ten years

Species	Total number of records	Most recent record	National grid reference of most recent record	Designation/status
American Mink *Neovison vison*	9	2020	[redacted]	WCA Sch9
American Signal Crayfish (*Pacifastacus leniusculus*)	7	2021		WCA Sch9 IAS 2019
Canadian pondweed *Elodea canadensis*	3	2018		WCA Sch9
Curly Waterweed *Lagarosiphon major*	1	2017		WCA Sch9
Entire-leaved Cotoneaster *Cotoneaster integrifolius*	1	2015		WCA Sch9
Few-flowered Garlic *Allium paradoxum*	2	2020		WCA Sch9
Giant Hogweed *Heracleum mantegazzianum*	16	2019		WCA Sch9 IAS 2019
Giant-rhubarb *Gunnera tinctoria*	2	2019		WCA Sch9 IAS 2019
Himalayan Balsam *Impatiens glandulifera*	38	2019		WCA Sch9 IAS 2019
Himalayan Cotoneaster *Cotoneaster simonsii*	9	2018		WCA Sch9
Hollyberry Cotoneaster *Cotoneaster bullatus*	2	2013		WCA Sch9
Japanese Knotweed *Reynoutria japonica*	12	2021		WCA Sch9
Japanese Rose *Rosa rugosa*	12	2019		WCA Sch9
Montbretia *Crocosmia pottsii* x *aurea* = *C.* x *crocosmiiflora*	8	2020		WCA Sch9
New Zealand Pigmyweed *Crassula helmsii*	8	2017		WCA Sch9

Species	Total number of records	Most recent record	National grid reference of most recent record	Designation/status
Nuttall's Waterweed *Elodea nuttallii*	8	2018	[redacted]	IAS 2019
Parrot's-feather *Myriophyllum aquaticum*	1	2019		WCA Sch9 IAS 2019
Rhododendron *Rhododendron ponticum*	7	2018		WCA Sch9
Small-leaved Cotoneaster *Cotoneaster microphyllus*	1	2016		WCA Sch9
Virginia-creeper *Parthenocissus quinquefolia*	4	2016		WCA Sch9
Wall Cotoneaster *Cotoneaster horizontalis*	24	2019		WCA Sch9
Water Fern *Azolla filiculoides*	2	2017		WCA Sch9

3.1.3 Historical records of invasive non-native aquatic macroinvertebrate and macrophyte species are available from the Environment Agency through their routine monitoring programme however, there were no Environment Agency records within 10 years of any invasive non-native aquatic macroinvertebrates, macrophytes, or fish.

3.1.4 Desk studies and surveys on the canal network during Gate 1 and Gate 2 did not reveal any 'high impact' aquatic invasive non-native macrophytes on the canal network other than waterweed (*Elodea* species) found in the River Tove and at GUC-09. Gate 2 surveys did not distinguish between Canadian pondweed and Nuttall's Waterweed.

3.1.5 The results of eDNA and sweep samples conducted in Gate 2 in 2021 and 2022 are presented in tables Table 3-2 for molluscs and Table 3-3 for crustaceans.

Table 3-2: Non-native molluscs found in Gate 1/2 (eDNA and sweep samples) 2021/2022

Gate 2 site ID	Gate 3 site ID	Asian Clam *Corbicula fluminea*	New Zealand Mud Snail *Potamopyrgus antipodarum*	Quagga Mussel *Dreissena rostriformis*	Zebra Mussel *Dreissena polymorpha*
3	OC-03	eDNA	Sample	-	eDNA
4	On Avon	-	-	-	-
5	GUC-04	-	-	-	-
6	GUC-05	eDNA	-	eDNA	eDNA/Sample
7	River Tove	-	-	-	-
8	GUC-09	-	-	-	-
9	River Ouzel	-	-	-	Sample

Table 3-3: Invasive non-native crustaceans found in Gate 1/2 (eDNA and sweep samples) 2021/2022

Gate 2 site ID	Gate 3 site ID	American Signal Crayfish *Pacifastacus leniusculus*	Caspian Mud Shrimp *Chelicorophium curvispinum*	Northern River Crangonyctid/Florida Crangonyctid *Crangonyx floridanus/ pseudogracilis*	Demon Shrimp *Dikerogammarus haemobaphes*
3	OC-03	-	Sample	-	Sample
4	On Avon	-	-	Sample	Sample
5	GUC-04	eDNA	Sample	-	Sample
6	GUC nr 5	eDNA	Sample	-	Sample
7	River Tove	-	-	Sample	-
8	GUC-09	-	Sample	-	Sample
9	River Ouzel	-	-	Sample	Sample

3.1.6 Anecdotal records on three invasive non-native fish were also obtained from the Trust. These include:

- Zander (*Sander lucioperca*): The Trust runs a programme to prevent further migration of Zander outside of their existing range and to remove all individuals. This is done through electric fishing by boom boat to capture and remove Zander from waterways. Zander have been recorded along all three canals.
- Wels Catfish (*Silurus glanis*): Between 2017 and 2020, the Trust removed a small number of adult Wels Catfish whilst completing their electric fishing programme for Zander within the GUC. These were caught between Three Locks and Cosgrove. In addition, two angling records of juvenile Wels Catfish were provided by the Trust. Firstly, during a fishing match at Fenny Stratford (between 2017 – 2018) a match angler caught four juvenile Wels Catfish (1 to 2 lbs) near Willowbridge marina. The second record was provided from the Trust via the Milton Keynes Angling Association, whereby a larger juvenile catfish (approx. 5 lbs) was caught south of the old A5 bridge at Bletchley (Watling Street; unknown year).
- Channel Catfish (*Ictalurus punctatus*): This species was believed to be caught during a Trust electric fishing programme at Stoke Bruerne, located on the Oxford canal at the intersection between GU Pound 13-14 and INT Pound 14-20. It should be noted that this species would be unable to support a viable population, as spawning requires water temperatures between 27-28°C.

3.1.7 Secondary data collected from other sources of information suggested that London Bur-marigold (*Bidens connata*), an annual herb of permanently damp cracks in stonework beside canals, started spreading north from London along the GUC with accelerating pace during the last two decades of the 20th century, reaching the northern edge of Buckinghamshire by the middle 1990s. Since then, it has continued its spread into Northamptonshire, reaching Northampton in the early years of the 20th century[14]. Whilst it is established and locally invasive, it does not have any significant negative impacts and is not scheduled on relevant legislation. The species is spread by humans and animals which pick up its seeds which have barbs catching on clothing and fur.

Drayton and Daventry Reservoirs

Daventry Reservoir

3.1.8 Daventry Reservoir (28 ha at an altitude of 120 m) is located within Daventry Country Park (66 ha), a Local Nature Reserve designated by Daventry District Council (2007). In addition to the reservoir, there are also meadows and crack-willow woodland. Daventry Reservoir and the immediately bordering land is designated as a County Wildlife Site by the Northamptonshire Wildlife Trust.

[14] Gent, G. and Wilson, R. (2012) The flora of Northamptonshire and the Soke of Peterborough. Robert Wilson Designs: Northants.

Daventry Country Park including the reservoir is owned and managed by West Northamptonshire Council.

3.1.9 The reservoir has a long dam section along its northern edge with much of the remaining edge being treed. The reservoir experiences significant drawdown (Figure 3-1).

3.1.10 In 1898, a sewage treatment works was built at the southern inflowing end of Daventry Reservoir to service the town (Roberts, 2022). These works were decommissioned in 1974. However, the sludge lagoons remained until 1992 when they were replaced with reedbeds (Eastwood *et al*., 2000). In the early 1970s, a grit trap was installed south of Daventry Reservoir by Daventry District Council to control the amount of sediment, and associated pollutants, entering the reservoir, as well as an oil trap to intercept sludge wastes from industry (Eastwood et al., 2000).

3.1.11 Recreational activities include:

- fishing: the reservoir is open all year round and fishing is permitted from dawn to dusk; no night fishing is allowed at any time;
- a limited number of permits available for non-powered water sports during the summer months including paddle boarding, canoeing, kayaking and model boating
- open water swimming during the summer months with sessions Sunday mornings from April to October;
- watching wildlife at several quiet locations around the park, including a dedicated bird hide and a nature trail;
- dog walking; the Park is a popular location for dogs and their owners;
- an adventure playground and a café; and
- feeding the ducks; packets of seed can be purchased from the café.

Figure 3-1: Aerial view of northern part of Daventry Reservoir showing dam and wooded margin

3.1.12 Ecological assessments of Drayton and Daventry Reservoirs have been completed and reported separately at Gate 3, and have informed this report:

- Preliminary Ecological Appraisal, Great Crested Newt (GCN) eDNA survey;
- Otter and water vole surveys; and
- Aquatic ecological assessments: macroinvertebrates, macrophytes, and fish eDNA.

Drayton Reservoir

3.1.13 Drayton Reservoir (Figure 3-2) (16 ha at an altitude of 135 m) is near the northern edge of Daventry and is accessible from the A361. As a feeder reservoir for the GUC, when water is required for the canal the water level at Drayton Reservoir can drop by 30 cm or more in a day. The reservoir was controlled by British Waterways until their responsibilities for waterways in England and Wales were transferred to the Canal & River Trust. The reservoir is bounded to the east by the A361, most of the rest of the reservoir is surrounded by adjacent housing.

3.1.14 Recreational activities include:

- walking: there is a 3.5-km circular trail around the reservoir, a popular trail open year-round to visit anytime;
- sailing: the reservoir is home to Rugby Sailing Club, formed in 1949, a Royal Yachting Association (RYA) recognised training centre, which organises dinghy sailing on the reservoir with races on Sunday for most of the year and Thursday evenings in the summer months (boat classes include Solo, Enterprise, GP14, Laser, Toppers and Optimists);
- open water swimming sessions which run from late April to September on Sunday mornings with two time slots starting at 08:30 and at 09:30 (the course is a 500 m rectangle and a shorter inner rectangle of 250 m);
- fishing: known to UK anglers as one of England's premier match fishing venues, the reservoir was stocked with 50,000 small Carp (*Cyprinus carpio*). Although the water is also stocked with Roach (*Rutilus rutilus*), Perch (*Perca fluviatilis*) and Pike (*Esox lucius*), the majority of anglers come to the reservoir for the Carp and which have grown quickly, 9lb (4 kg) Drayton Reservoir carp are commonplace, 20lb (9 kg) Carp are caught very regularly, with larger specimens available topping out at 35lb (16 kg), such that anglers are advised to ensure they have angling equipment that can handle the large fish and that they watch their rods and poles. Hundreds of rods and poles have been pulled into the reservoir by fish (https://en.wikipedia.org/wiki/Drayton_Reservoir). Pike reach 26lb (12 kg). Drayton Reservoir benefits from excellent accessibility due to being surrounded by a modern wooden walkway round most of the water (Figure 3-2) making it easy to reach any of the 123 pegs. Known to be a runs water (runs waters are well-stocked fishing water bodies where anglers can expect regular catches or runs), a variety of techniques work well at Drayton Reservoir. Night fishing is available on certain pegs. The Trust manage the fishery with bailiffs patrolling every few hours.

Figure 3-2: Aerial view of northern part of Drayton Reservoir showing Rugby Sailing club and boardwalk with fishing pegs

3.2 Field Surveys – Canals and Rivers

Invasive Non-native Flora

Botanical Surveys

3.2.1 No invasive non-native macrophyte species were found growing either submerged or emergently during the macrophyte surveys. However, there were two terrestrial invasive non-native plant species recorded growing along the canals:

- Himalayan Balsam (*Impatiens glandulifera*) was found growing extensively along the banks of the River Ouzel. It was first introduced in 1839 as a garden plant but escaped and spread into the wild along waterways[15]. Its explosive seed pods aid in its rapid spread, particularly along waterways where they can travel downstream. Himalayan Balsam was listed under Schedule 9 of the WCA, making it an offence to plant or cause its spread into the wild, it is now covered by the Invasive Alien Species (Enforcement and Permitting) Order 2019 ('IASO') which also makes it an offence to plant or cause its spread into the wild, along with additional restrictions.
- Butterfly-bush (Summer Lilac) (*Buddleja davidii*) was found growing on the banks of OC-02 and CC-04. Originating from China, it was introduced in the UK in the 1890s as a garden plant but, similarly to Himalayan Balsam, escaped and has spread across the UK in the wild[16]. Though an invasive non-native, this plant is not scheduled on relevant legislation.

Fish Habitat Surveys

3.2.2 During the fish habitat survey in 2023, which covered the majority of the canal used in the proposed Scheme by sampling from a boat, the following invasive non-native plant species were found:

- Nuttall's Waterweed (*Elodea nuttallii*) was found growing close to emergent macrophytes on the offside bank in a patch approximately three meters long between GUC-01 and GUC-02 (SP 60975 65471). This plant was first recorded in Oxfordshire in 1966. It is thought to be an

[15] https://www.wildlifetrusts.org/wildlife-explorer/wildflowers/himalayan-balsam.
[16] https://www.wildlifetrusts.org/wildlife-explorer/trees-and-shrubs/buddleia

escapee from a pond or aquarium and is now considered widespread across England[17]. Nuttall's Waterweed is listed in the Invasive Alien Species Permitting Order 2019, making it an offence to plant or cause its spread.

- Orange Balsam (*Impatiens capensis*) was found at several locations on the canal network. It is listed on the London Invasive Species Initiative[18] but is not considered a 'high impact' species, i.e., it is not scheduled on relevant legislation.

Invasive Non-native Macroinvertebrates

3.2.3 A total of four invasive non-native molluscs and five invasive non-native crustaceans were found during the 2023 surveys (eDNA and sweep and dredge). These species were:

- American Signal Crayfish was detected by eDNA surveys at all but one site on the canals, where there were sampling limitations. It is therefore considered present throughout. Just one American Signal Crayfish was captured during sweep and dredge sampling, though with this species tending to remain in burrows during the day, it is not surprising that these survey techniques did not capture more. American Signal Crayfish is native to North America and was introduced to the UK for aquaculture purposes in the 1970s and has spread extensively since then[19]. It is listed under Schedule 9 of the WCA.
- American Lake Limpet (*Ferrissia fragilis*) was found in sweep and dredge samples at two locations (GUC-01 and OC-02) with very low abundance (two individuals at each site). This species was not found in previous surveys by APEM. It is therefore possible that this is a new invader of the canal system, though it may be more prevalent than the survey results suggest due to its small size (approximately 2 mm long) and it being difficult to dislodge during netting. The American Lake Limpet is thought to have been introduced to the UK through the aquarium trade, by unwitting release through aquarium waste disposal[20]. The species is able to reproduce asexually, which provides advantages in the colonisation of new habitats, with just one introduced individual able to replicate.
- Asian Clam was detected in the eDNA and aquatic macroinvertebrate surveys in the Coventry Canal, Oxford Canal and parts of the GUC (except for GUC-04, GUC-05, and GUC-07,08 and 09). In 2021, Gate 2 INNS surveys detected Asian Clam in two locations only, one at OC-03 and on the GUC near GUC-05. Both were via eDNA, and no physical specimens were captured. As Asian Clam were found extensively in 2023 both in eDNA and physical specimens, this indicates that this high impact mollusc has only recently colonised the canal and is reproducing and spreading rapidly. Asian Clam is native to China, Korea, Russia, Australia, and Africa and invasive in the Americas and Europe[21]. Its pathway into the UK is unknown, but likely to have been via ballast water. Although it is not included under any UK legislation, it is one of the most widespread invasive freshwater bivalves in the Northern hemisphere.
- Bloody Red Shrimp *(Hemimysis anomala*) was found as single individuals in just two sites. This is perhaps surprising as Bloody Red Shrimp form large colonies. However, they also seek shelter during the day when the surveys took place and emerge at night, so it is likely that this species has been under-recorded in the surveys. This species is native of the Ponto-Caspian region. It was first recorded in the UK in the Erewash Canal in 2004[22].
- Caspian Mud Shrimp was present in high abundances throughout the canal system during the surveys in 2023 and in the surveys by APEM in 2021/2022. The Caspian Mud Shrimp is an amphipod which originates from the Ponto-Caspian basin. It was first recorded in Britain in 1935[23] and has a high fecundity but short life span.

[17] https://www.nonnativespecies.org/assets/Uploads/Elodea_nuttallii_Nuttalls_waterweed.pdf
[18] http://harrowinleaf.org.uk/download/LISI_species_of_concern_Nov2014.pdf.
[19] Holdich, D. M., Sibley, P. J. & Peay, S. (2004) The white-clawed crayfish - a decade on. British Wildlife 15, 153-164.
[20] Vecchioni, L., Marrone, F., Arculeo, M. & Arizza, V. (2017) Are there autochthonous Ferrissia (Mollusca: *Planorbidae*) in the Palaearctic? Molecular evidence of a widespread North American invasion of the Old World, The European Zoological Journal, 84:1, 411-419, DOI: 10.1080/24750263.2017.1350759.
[21] Howlett, D. & Baker, R. (1999) *Corbicula fluminea* (Muller): New to UK. Journal of Conchology 36: 83-83.
[22] Holdich, D. & *et al.* (2006) The invasive Ponto-Caspian mysid, *Hemimysis anomala*, reaches the UK. Aquatic Invasions.
[23] Crawford, G. (1935) *Corophium curvispinum*, G. O. Sars, var *devium*, Wundsch, in England. Nature 136, 685 (1935). https://doi.org/10.1038/136685c0

- Northern River Crangonyctid and, or Florida Crangonyctid was found in small numbers occasionally on each of the three canal systems surveyed. Northern River Crangonyctid was first identified in London in 1935, while the first record of *Florida Crangonyctid* was much later in 2018[24]. However, due to the difficulty in separating the species, it is likely that *C. floridanus* has been present in the UK for longer but had been misidentified as *C. pseudogracilis.* Due to their morphological and ecological similarities, it is standard practice in ecological assessments to treat the two species as one.
- Demon Shrimp has thoroughly colonised the canals having been found throughout the canal system with the exception of GUC-09, although it was found in samples at this location by APEM in 2021. It was found at all survey locations on the canal systems and the River Avon and River Tove by APEM. It [25]. It has been shown to be associated with Zebra M[26] though there was no obvious link between the two species in the data gathered during these surveys.
- New Zealand Mud Snail was present in very small numbers on the GUC, in rather higher numbers on the Oxford Canal, and was not found on the Coventry Canal. The New Zealand Mud Snail is native to New Zealand and adjacent islands. It was first recorded in the UK in 1852 in the Thames estuary, introduced via drinking water barrels. It has been widespread in the UK since around 1920 and is now one of the commonest aquatic snails in the UK[27].
- Zebra Mussel was found widely throughout the canal systems surveyed, with eDNA showing Zebra Mussel to be abundant throughout the canal system and in the River Ouzel. Dredge sampling found either live individuals or empty Zebra Mussel shells on every canal. The species is native to the drainage basins of the Black, Caspian and Aral Seas and was first recorded in the UK in Wisbech in the 1820s[28].

Sweep and Dredge Surveys

3.2.4 Nine species of invasive non-native aquatic macroinvertebrates were found during the sweep and dredge surveys. These include American Signal Crayfish, Asian Clam, Bloody Red Shrimp, Caspian Mud Shrimp, Northern River or Florida Crangonyctid, Demon Shrimp, New Zealand Mud Snail and Zebra Mussel. The full results of the sweep and dredge surveys are presented in Table 3-4 (invasive non-native molluscs) and Table 3-5 (invasive non-native crustaceans).

Table 3-4: Non-native molluscs found in Gate 3 canal surveys[29]

Gate 3 ID	American Lake Limpet *Ferrissia californica*	Asian Clam *Corbicula fluminea*	New Zealand Mud Snail *Potamopyrgus antipodarum*	Zebra Mussel *Dreissena polymorpha*
CC-01	-	-	-	empty shells
CC-02	-	1	-	empty shells
CC-03	-	-	-	empty shells
CC-04	-	-	-	7
GUC-01	2	-	1	-
GUC-02	-	13	2	-
GUC-03	-	2	2	1
GUC-04	-	2	2	empty shells
GUC-05	-	1	2	-

[24] Mauvisseau, Q., Davy-Bowker, J., Bryson, D., Souch, G.R., Burian, A. & Sweet, M. (2018) First detection of a highly invasive freshwater amphipod (*Crangonyx floridanus*) in the United Kingdom. BioRxiv: 437301. doi: https://doi.org/10.1101/437301.
[25] Aldridge, D.C. (2013) GB Non-native Organism Rapid Risk Assessment for *Dikerogammarus haemobaphes* (Eichwald, 1841). ww.nonnativespecies.org.
[26] Kobak, J. & Zytkowicz, J. (2007) Preferences of invasive Ponto-Caspian and native European gammarids for zebra mussel (*Dreissena polymorpha*, Bivalvia) shell habitat. HYDROBIOLOGIA 589, 43-54.
[27] Alonso, A. & Castro-Díez, P. (2008) What explains the invading success of the aquatic mud snail *Potamopyrgus antipodarum* (Hydrobiidae, Mollusca)? Hydrobiologia 614:107-116.
[28] Aldridge, D.C., Elliott, P. & Moggridge, G.D. (2004) The recent and rapid spread of the zebra mussel (*Dreissena polymorpha*) in Great Britain. Biological Conservation, 119, 253-261.
[29] Values are abundances of individuals in sweep and dredge samples following PSYM methodology.

Gate 3 ID	American Lake Limpet *Ferrissia californica*	Asian Clam *Corbicula fluminea*	New Zealand Mud Snail *Potamopyrgus antipodarum*	Zebra Mussel *Dreissena polymorpha*
GUC-06	-	-	1	1
GUC-07	-	-	2	4
GUC-08	-	-	-	1
GUC-09	-	-	-	81
OC-01	-	1	-	empty shells
OC-02	2	4	-	2
OC-03	-	14	30	1
OC-04	-	70	12	-
OC-05	-	3	-	2

Table 3-5: Non-native crustaceans found in Gate 3 surveys[30]

Gate 3 ID	American Signal Crayfish *Pacifastacus leniusculus**	Bloody-red Mysid *Hemimysis anomala*	Caspian Mud Shrimp *Chelicorophium curvispinum*	Northern River or Florida Crangonyctid *Crangonyx floridanus/ pseudogracilis*	Demon Shrimp *Dikerogammarus haemobaphes*
CC-01	-	-	-	-	3
CC-02	-	-	30	3	28
CC-03	-	1	114	-	15
CC-04	-	-	8	-	3
GUC-01	-	-	32	-	54
GUC-02	-	-	2	-	9
GUC-03	-	-	13	9	36
GUC-04	-	-	218	-	19
GUC-05	-	-	126	-	12
GUC-06	-	-	6	-	33
GUC-07	-	-	6	-	2
GUC-08	-	-	7	4	12
GUC-09	-	-	2	-	-
OC-01	-	-	12	3	23
OC-02	-	-	10	3	43
OC-03	1	-	25	13	8
OC-04	-	1	113	-	21
OC-05	-	-	106	-	4

**INNS with statutory regulation*

eDNA Surveys

3.2.5 Three species of invasive non-native aquatic macroinvertebrates (American Signal Crayfish, Asian Clam and Zebra Mussel) were found in the majority of the sampling sites along the three canals during

[30] Values are abundances of individuals in sweep and dredge samples following PSYM methodology.

the eDNA surveys. A further species of *Dreissena* was also identified, which may indicate the presence of Quagga Mussel *(Dreissena rostriformis bugensis*); however, this species was not found in macroinvertebrate surveys so is considered currently absent. Table 3-6 summaries the eDNA results for invasive non-native aquatic macroinvertebrates.

Table 3-6: Non-native macroinvertebrates found in Gate 3 surveys[31]

Gate 3 ID	American Signal Crayfish *Pacifastacus leniusculus**	Asian Clam *Corbicula fluminea*	*Dreissena* species (possibly Quagga Mussel *Dreissena rostriformis bugensis*)	Zebra Mussel *Dreissena polymorpha*
CC-01	Positive	Positive	Positive	Positive
CC-02	Positive	Positive	Positive	Positive
CC-03	Positive	Positive	Positive	Positive
CC-04	Positive	Positive	Positive	Positive
GUC-01	Positive	Positive	Positive	Positive
GUC-02	Positive	Positive	Positive	Positive
GUC-03	Positive	Positive	Positive	Positive
GUC-04	Negative	Negative	Negative	Negative
GUC-05	Negative	Negative	Negative	Positive
GUC-06	Positive	Positive	Positive	Positive
GUC-07	Positive	Negative	Positive	Positive
GUC-08	Positive	Negative	Negative	Positive
GUC-09	Positive	Negative	Positive	Positive
OC-01	Positive	Positive	Positive	Positive
OC-02	Positive	Positive	Positive	Positive
OC-03	Positive	Positive	Positive	Positive
OC-04	Positive	Positive	Positive	Positive
OC-05	Positive	Positive	Positive	Positive
AVON INNS	Positive	Negative	Negative	Negative
OUZEL INNS	Positive	Negative	Negative	Positive
TOVE INNS	Positive	Negative	Negative	Negative

**INNS with statutory regulation*

[31] 'Positive' indicates there is a presence of that species DNA in the sample, 'Negative' indicates no trace of DNA from the species was found the in sample.

Invasive Non-native Fish

eDNA Surveys

3.2.6 Two invasive non-native fish species were found during the eDNA surveys:

- Zander was present at all surveying sites except for GUC-04, GUC-05 and GUC-09. Zander was illegally introduced to the canal network in the Coventry area in early to mid-1970s. Within canals, they have been shown to have a deleterious effect on the native fish population and are listed on Schedule 9 of the WCA.
- Catfish eDNA (species of *Siluriformes*) was identified within CC-04 only. Unfortunately, the taxonomic rank of this DNA could not be identified to species level and therefore there is uncertainty as to which catfish species it refers to. From anecdotal evidence provided by the Trust, it is highly likely that this is Wels Catfish. This species is listed on Schedule 9 of the WCA.

Invasive Non-native Mammals (American Mink)

eDNA Surveys

3.2.7 No American Mink was detected during the eDNA surveys.

Riparian Mammal Surveys

3.2.8 During the riparian mammal surveys, evidence of American Mink was only found at one survey location, CC Pound 1-1. American Mink was first introduced to the UK in the 1929 as an escapee from fur farms[32]. It has been a key factor in Water Vole population decline due to predation. As Water Vole are protected under various bits of UK legislation (e.g. Schedule 5 of the WCA), and American Mink are listed as invasive under Schedule 9 of the WCA, it is imperative that the Scheme does not aid in their spread along the canal and river systems.

3.3 Field Surveys – Reservoirs

Daventry Reservoir

3.3.1 The following invasive non-native species were found during the field surveys of the Daventry Reservoir:

- Northern River and/or Florida Crangonyctid was found at all sampling points.
- Canadian pondweed (*Elodea canadensis*) was found growing abundantly across the reservoir.
- Parrots-feather (*Myriophyllum aquaticum*) was found growing in a pond that was located next to the Daventry Reservoir. It is assumed that the two water bodies are hydrologically linked however, this is not confirmed. Parrots-feather was first recorded in the wild in the 1960s[33]. It spreads via fragmentation and forms dense mats which shade other aquatic plants which impacts the aquatic macroinvertebrate communities.
- Himalayan Balsam (*Impatiens glandulifera*) found in the pond next to the reservoir.

Drayton Reservoir

3.3.2 The following invasive non-native species were recorded during the field surveys of the Drayton Reservoir:

- Northern River and, or Florida Crangonyctid was found at all sampling points.
- New Zealand Mud Snail was found at all sampling points.

[32] Cuthbert, J.H. (1973) The origin and distribution of feral mink in Scotland. Mammal Review 3: 97-103.
[33] Dawson, F.H. (1993) Comparison of the rates of naturalisation of the invasive alien aquatics, Crassula helmsii and Myriophyllum aquaticum. BSBI News 63: 47-48.

3.4 Summary

Invasive Non-native Macrophyte Flora

3.4.1 Records of 20 invasive non-native macrophyte flora species were returned from the record centre. Of these records, only two of the species were also recorded during the field surveys. These were Himalayan Balsam (WCA) and Nuttall's Waterweed. The latter species was originally scheduled on the WCA but has been moved to IASO.

3.4.2 In Gate 2 surveys, a waterweed (*Elodea* species) was also found on the River Tove and at GUC-09 however, the surveys did not distinguish between Canadian Waterweed and Nuttall's Waterweed. It is possible this was Nuttall's Waterweed based on the findings of the 2023 surveys.

3.4.3 The other two non-native species found during the field surveys along the canals were Butterfly-bush and Orange Balsam however, these species are not listed in relevant legislation, and, therefore, no specific action is required relating to these species.

3.4.4 During all Gate 2 and Gate 3 surveys, none of the macrophyte INNS that are particularly known to cause significant ecological and financial issues in canals, such as Floating Pennywort (*Hydrocotyle ranunculoides*), New Zealand Pigmyweed (*Crassula helmsii*) and Water Fern (*Azolla filiculoides*) were found.

Invasive Non-native Aquatic Macroinvertebrates

3.4.5 Records of only one INN macroinvertebrate (American Signal Crayfish) was returned from the desk study data. This could be because, unless deliberately surveyed for, macroinvertebrates can be quite difficult to see along canal and river systems in comparison to plant species and are therefore under-recorded.

3.4.6 Data from the field surveys suggest that the three canal systems were dominated by non-native molluscs and crustaceans, the majority of which are not scheduled on the Wildlife and Countryside Act or the Invasive Alien Species Order. These were American Lake Limpet, Asian Clam, Bloody Red Shrimp, Caspian Mud Shrimp, a species of *Crangonyx*, Demon Shrimp, New Zealand Mud Snail and Zebra Mussel. . Furthermore, species such as Zebra Mussel and Asian Clam are known to cause major impacts to the waterways and water infrastructure, e.g. pipework, across the UK, so it was imperative that they were included within the INNS risk assessment.

3.4.7 Asian Clam appears to have colonised the canal network earmarked for the Scheme in recent years. Gate 2 surveys detected eDNA markers in just two locations but found no specimens in samples, while desk studies did not hold records for them. Gate 3 surveys found live specimens in the majority of the canal sites and eDNA evidence in 13 out of 18 of the canal sites. This suggests that they are a recent invader and have been very successful in population growth and spread.

3.4.8 American Signal Crayfish was the only macroinvertebrate species found that falls under Schedule 9 of the WCA. This was also found to be widely distributed along the three canals.

Invasive Non-native Fish

3.4.9 No records of INN species from the LERCs were returned. Anecdotal evidence obtained from the Trust suggest that three INN fish species are present – Zander, Wels Catfish and Channel Catfish.

3.4.10 Two species of INN fish were identified during the 2023 surveys. These were Zander and possibly Wels Catfish (see section 3.2.3). Zander populates almost all of the canal system whereas the Wels Catfish was only found at one sampling site. Both of these species are listed under Schedule 9 of the WCA, and it is therefore considered an offence to release or allow them to escape into the wild.

Invasive Non-native Mammals (American Mink)

3.4.11 Nine records of American Mink were returned from the desk study data. The majority of these records were located around Leighton Buzzard and Milton Keynes (see Appendix A).

3.4.12 During the field surveys, evidence of American Mink was found at only one sampling site in the Coventry Canal. It is possible that since 2020 (the latest Mink record), they have begun to spread upstream of the canal system, which could account for the lack of Water Vole evidence downstream of the Scheme (see Gate 3 Water Vole Report) However, as there are so few records and only one piece of evidence found, this cannot be considered a comprehensive argument and therefore, a meaningful conclusion is difficult to make.

Reservoirs

3.4.13 No records of invasive non-native species in the two reservoirs were returned from the desk study data.

3.4.14 Two INNS were recorded in Daventry Reservoir (Northern River Crangonyctid and Canadian pondweed) and two were recorded in Drayton Reservoir (Northern River Crangonyctid and New Zealand Mud Snail). A further two were recorded in a pond next to the Daventry Reservoir which were Himalayan Balsam and Parrot's Feather.

3.4.15 Only two INNS are present in both the reservoirs and the canal system which are Northern River Crangonyctid and New Zealand Mud Snail.

4. Discussion and Recommendations

4.1 INNS Risk Assessment

4.1.1 Broadly speaking, INNS risk associated with the GUC SRO can be usefully divided into four topics, which cover the potential that:

- INNS are introduced to the canal network from previously unconnected locations, or due to development activity, from where the INNS could be further dispersed;
- the rate of spread of INNS already present within the canal network could be increased and, consequently, the rate of spread to connected water bodies/waterways;
- INNS could reach new locations within the canal network and/or parts of the network could become more suitable to INNS;
- INNS could spread to new locations that were previously unconnected or ‘upstream' of the canal network.

4.1.2 These four topics are summarised in Table 4-1 below. Where there is significant scope for development activity related to the Scheme to facilitate INNS movements, mitigation requirements for such risks are well established and relatively easy to implement, this hazard only presents a low risk, and the topic is dealt with in full in Table 4-1. Where the risk is classed as high, mitigation is more complex and additional information is provided below the table.

Table 4-1: Potential impacts of the GUC transfer scheme on INNS

Potential impact/pathway	Risk Overview	Overview of Conclusions and Recommendation
INNS introduction to the canal network from previously unconnected locations or due to development activity	Due to the existing, very significant, and long established hydrological connectively between the three sections of the canal network, which are further connected to three river systems, any INNS introduction to this network, as part of the GUC scheme, would come with a high risk of further significant spread beyond the point of introduction. As the only new hydrological connection into the network is treated water from the proposed source (Minworth SRO), the primary risk here is associated with accidental introduction during development of the scheme (e.g. attached to plant or equipment used to upgrade canal infrastructure).	At the start of the route, recycled water from Minworth WwRC will be transferred into the Coventry Canal. This water will have been treated using both conventional approaches and an Advanced Wastewater Treatment Plant. **No risk** of INNS introduction from Minworth WwRC was identified as part of the Minworth SRO INNS Risk Assessment. Due to the potentially large scale of the works required to upgrade the canal network, with modifications being required for to up to 54 km of bank and tow path and 57 existing waste weirs, there will be opportunities for accidental introductions. Concomitantly, such works could facilitate spread away from the canal network (as INNS were recorded in all parts of the canal network). While there is significant scope for development activity related to the scheme to facilitate INNS movements, mitigation requirements for such risks are well established and relatively easy to implement. As such, this hazard only presents a **low risk**. A Biosecurity Management Plan (BMP) should be produced for the scheme.
Increased rate of spread of INNS along the canal network and, consequently, the rate of spread to connected water bodies/waterways, due to Increased water volume, depth, and flow rate, in the canal network, and/or due to new bypasses (e.g. of locks) or via waste weirs, potentially reducing resistance to INNS spread along the canal network.	The canal network has been invaded by a wide range of INNS. These INNS spread by water flow, or in water, and have been recorded in all parts of the canal network. As such, changes to the hydrology of the canal network could result in a change to how INNS are moving through the network. From a high-level perspective, connectivity between canal sections, and associated river systems, will be unchanged. The waterways are connected, have been for a very long time, and will remain so. This existing level of connectivity has presumably facilitated the widespread colonisation of the network, with several species being recorded throughout the network. Additionally, it appears that INNS can currently proliferate through the network relatively quickly, based on the observed rapid increase in Asian Clam presence from 2021 to 2023 As such, the focus of this assessment is to understand if the predicted changes in flow rate, water depth, and the introduction of bypasses, will have a meaningful impact on the current, already significant, rate of INNS spread.	While the volume of water moving through the canal network will increase, which in turn will modify flow rates and water depth, the SRO already includes provisions to ensure these modifications do not result in significant negative ‘hydrological consequence’. For example: • Steps will be taken to ensure that flow rates remain below the allowable threshold for the canal (set at 0.3 m/s to ensure that boat navigation is not hindered). • In most locations, predicted mean water levels are within +/- 0.15m of the baseline for the 115Ml/d scenario. In the context of typical canal depts (generally 1.0 - 1.5 m) and the habitat preferences of the INNS present, this is not a meaningful change. Additionally, this change in depth is not predicted to result in additional water loss to adjacent watercourses due to the planned raising of canal infrastructure. As such, these changes in hydrology are **unlikely to significantly modify INNS risk**. While a number of locks, or other canal features (such as constriction points), will be bypassed, these works don’t change overall connectivity, rather it just changes the means by which INNS could move from one side of a lock, for example, to the other. Overspill of the canal to connected water bodies via waste weirs will not be increased or altered as a result of the operation of the scheme; where required, waste weirs will be raised to prevent water loss from the canals, and therefore this will not increase the risk of INNS transfer from the canals. These changes, in the context of the force by which water moves through locks, and considering the unchanged overspill from waste weirs, are **unlikely to significantly modify INNS risk**.
Facilitating the spread of INNS to new locations within the canal network, due to Increased water volume, depth, and flow rate in the canal network, potentially allowing INNS to reach new locations	Similarly to the above, the risk that the proposed modifications to the hydrology of the networks might create new, more suitable conditions, within the network, has been assessed.	As above, the increased depth/flow and the associated proposed infrastructure upgrades, will result in relatively minor (in the context on INNS biology and habitat preference) changed in hydrology. While it is poss ble that some locations may become marginally more favourable for some species, in turn, some location may become marginally less favourable for other species.

Potential impact/pathway	Risk Overview	Overview of Conclusions and Recommendation
and/or making parts of the network more suitable to INNS.	Once again, it is worth noting that the canal network is already heavily invaded.	Accordingly, based essentially on the same rational as above, the proposed changes in hydrology are **unlikely to significantly modify INNS risk**, with respect to creating more favourable conditions for INNS within the network.
Spread of INNS to new locations, that were previously unconnected or 'upstream' of the canal network, due to the Creation of new water routes (transfer to Drayton and Daventry Reservoirs; abstraction from GUC to new storage reservoir).	Options for the proposed Scheme include new connections being created to three reservoirs, Daventry Reservoir, Drayton Reservoir, and the storage reservoir and Water Treatment Works at Bletchley. [The underground reservoir near Luton will be a hydrological 'dead end' which is preceded by treatment works with water subsequently transferred to the reservoir by pipeline. Therefore, there is no potential for INNS to enter this part of the scheme.] As such, this part of the assessment focuses on the proposed new connections to Drayton and Daventry Reservoirs, and the storage reservoir at Bletchley, which will place these reservoirs effectively 'downstream' of the GUC.	New connections would place three reservoirs 'downstream' of the GUC. INNS have been recorded in the GUC that are not in the reservoirs. There are a large number of INNS recorded in the GUC, and a relatively small number recorded in the reservoirs; there will be no INNS present initially in the Bletchley storage reservoir. The proposed point of abstraction for Drayton and Daventry Reservoirs is near sampling point GUC-01. The INNS recorded in this location were American Lake Limpet, American Signal Crayfish, Asian Clam, Caspian Mud Shrimp, Demon Shrimp, New Zealand Mud Shrimp, Zander, and Zebra Mussel, none of which have been recorded in Daventry or Drayton reservoirs. Canadian pondweed is present in Daventry reservoir. The proposed point of abstraction for the Bletchley storage reservoir is between sampling locations GUC-07 and GUC-08. INNS recorded here were zebra mussel, demon shrimp, Caspian mud shrimp, American signal crayfish, *Crangonyx* sp., and New Zealand mud snail. Abstractions from the GUC will be screened to prevent the entrainment of fish, l kely to be a screen aperture of 3 – 12.5 mm, to be confirmed through design and through consultation with the Environment Agency (refer to GUC Fish Habitat Assessment report for further details). While this would be sufficient to prevent the entrainment of larger INNS and INNS propagules (e.g., plant fragments), it would not be sufficient to screen out juvenile crayfish and larval / smaller macroinvertebrates (e.g., bivalve veligers). There is a **high risk** that the proposed new connections to the existing and new reservoirs could introduce INNS from the GUC. See below for further commentary. While developing mitigation options for this aspect of the SRO are challenging, both due to the nature of aquatic INNS, but also due to unknowns relating to the effectiveness of available mitigation options, the risk of INNS instruction/establishment can be reduced. See below for further commentary. Regardless of the above, while risk to the reservoirs will be difficult to fully mitigate, there is considered to be no significant additional onwards risk. Specifically, Daventry and Drayton reservoirs will flow back into the GUC, which is nearby, and there will be no onward pathway for transfer from the Bletchley storage area. There are several additional waterways downstream of Drayton and Daventry reservoirs, but these are also similarly connected to the GUC. As such, at a regional scale, regardless of any local specific risk to the reservoirs, there is no change to wider INNS risk, considering the implementation of mitigation measures described below. As such, the INNS risk associated with abstracting from the GUC to the reservoirs should be considered **low in aggregate.**

Daventry and Drayton Reservoir, and Bletchley Storage Reservoir

4.1.3 Daventry and Drayton Reservoirs are already connected to the GUC by feeder channels from the reservoirs into the GUC and these connections are vital to the operation of the canal system. They enable water levels to be regulated at times of unusually low rainfall and to compensate for water lost through the operation of locks.

4.1.4 These links have been established for over 200 years. As such, given the difference between the INNS complement of the GUC and the reservoirs, these existing hydrological connections do not seem to have played a significant role in the spread of INNS. While this lack of uniformity is reasonably unsurprising in the direction GUC to reservoirs (as the reservoirs are 'upstream' and the GUC is 'downstream'), it is less so in the other direction; there are many more INNS in the canals than in the reservoirs.

4.1.5 The proposed Bletchley storage reservoir is entirely new, and water will be abstracted from the GUC for storage in the reservoir, prior to treatment and transfer by pipeline to AfW's drinking water network. Therefore, it is likely that INNS would be transferred from the GUC to the storage reservoir in time.

4.1.6 Given the proximity of Drayton and Daventry reservoirs to sources of INNS and the extended period for which they have been in operation, coupled with the presence of several introduction pathways known to be leading routes for the spread of INNS (e.g. boating and angling), it is surprising that INNS records for the reservoirs are as impoverished as they are. This lack of similarity between the GUC and the reservoirs, with respect to INNS compliment, could indicate that the conditions in the GUC, compared to the reservoirs, are sufficiently different that they do not support similar species assemblages.

4.1.7 Given the low number of INNS recorded (in the context of local presence), the current invasibility of the reservoirs appears to be low. The following conditions in Drayton Reservoir and Daventry Reservoir could help explain this observation.

Drayton Reservoir

4.1.8 The activities on the reservoir create a severely hostile environment for any plant or animal seeking to establish itself due to factors such as:

- disturbance and predation/feeding by the fish population which includes Common Carp;
- disturbance due to sailing and swimming;
- water turbidity and, consequently, the limited light regime;
- lack of any significant sections of riparian vegetation due to much of the shoreline being overshadowed by the wooden walkway from which anglers fish; and
- irregular drawdown of the water creating an unstable riparian zone.

Daventry Reservoir

4.1.9 The activities on the reservoir create a relatively hostile environment for any plant or animal seeking to establish itself due to factors such as:

- disturbance and predation/feeding by the fish population;
- some disturbance due to sailing and swimming;
- water turbidity and, consequently, the limited light regime; and
- Irregular and substantial drawdown of the water creating an unstable riparian zone inhibiting the establishment of submerged and riparian species.

Bletchley Storage Reservoir

4.1.10 The new storage reservoir will have no existing INNS present, so INNS risks are associated with their introduction from the GUC via the abstraction, the establishment of INNS in the new reservoir, or the onward spread of INNS from the reservoir during operation.

4.1.11 In addition to existing and proposed (i.e., screening at abstraction) barriers to invasion, there are a range of options to further reduce the invasibility of the systems, which are summarised in Table 4-3.

4.1.12 The proposed Scheme would see water from the canal pumped to ‘top-up’ Daventry and Drayton Reservoirs. Water ‘upstream’ (north-west) of the points at which the Daventry and Drayton Reservoirs discharge into the GUC will be piped up into the reservoirs and stored until needed to sustain the transfer along the canal. This creates two new pathways for INNS to be spread from the canal into one or both reservoirs.

4.1.13 Similarly, there is a likelihood of INNS transfer from the GUC to the new Bletchley storage area.

4.1.14 This could constitute a significant risk of these water bodies becoming colonised by INNS from the canal system. These reservoirs are currently free from the 11 non-native and/or invasive species found during the Gate 3 field surveys of the canals.

4.1.15 Table 4-2 summarise the potential impacts different INNS could have on the three reservoirs (and their native flora and fauna in the case of Drayton and Daventry Reservoirs), and the activities undertaken in the reservoirs species they harbour.

Table 4-2: Summary of potential impacts if INNS present in the GUC are introduced to Daventry Reservoir and Drayton Reservoir, and the new Bletchley storage reservoir

(No, Low, Medium, and High Risk relate to the probability that the specified risk will be realised as a result of the Scheme in the absence of additional mitigation).

Potential impacts	Risk to Drayton Reservoir	Risk to Daventry Reservoir	Risk to Bletchley storage reservoir
Outcompeting native species for resources e.g. Nuttall's Waterweed can form large mats across the surface of water bodies lowering light and oxygen levels. Dense growth could also negatively impact water-sports including open swimming.	**Low Risk**: There is an absence of any significant submerged flora, indicating conditions are not suitable for the establishment of dense aquatic vegetation.	**Low Risk**: Canadian pondweed is already present in Daventry Reservoir and therefore the existing risk will not be escalated.	**No Risk:** As a new reservoir, there will be no native species present.
Spread of diseases e.g. American Signal Crayfish acting as a vector for crayfish plague (*Aphanomyces astaci*) impacting native species White-clawed Crayfish (*Austropotamobius pallipes*)[34].	**No Risk**: No direct risk to White-clawed Crayfish as the species is not present. There is an indirect risk due to onward spread by, for example, anglers and paddle boarders.	**No Risk**: No direct risk to White-clawed Crayfish as the species is not present. There is an indirect risk due to onward spread by, for example, anglers and paddle boarders.	**No Risk**: No White-clawed Crayfish present and no public access with respect to onward spread.
Predation on fish eggs by American Signal Crayfish	**Low Risk**: If Signal Crayfish were to establish in the reservoir there could be negative impacts on the carp fishery and other species. However, crayfish are a preferred prey for carp, and given the lack of signal crayfish in the reservoir (despite local presence elsewhere), the carp appear to represent a suitable biological control agent. It would still be sensible to employ mitigations to minimise the rate of potential introductions, see below.	**Low Risk**: As with Drayton Reservoir, but lower in risk, as the fishery is of less value than in Drayton Reservoir.	**No Risk**: No fish present
Feeding on fishermen's bait by American Signal Crayfish	**Low Risk**: Potential negative impact on the Carp fishery due to interference with and feeding on bait. However, the caveats above are relevant here also.	**Low Risk**: As with Drayton Reservoir, but lower in risk, as the fishery is of less value than in Drayton Reservoir.	**No Risk**: No fish present
Biofouling e.g. Zebra Mussel can clog water pipes, filters and turbines in water treatment works and power station intakes[35].	**Medium Risk**: Transfer of water from the GUC to the reservoirs via pumps and pipelines presents a risk of biofouling by zebra mussel, which are present in the GUC but not in the reservoirs. Subsequently there is a risk of biofouling in the downstream connections to the GUC should zebra mussels be introduced to the reservoirs. Prevention of zebra mussel transfer is the best mitigation; however, there are mitigation options for biofouling, should that occur – see below.	**Medium Risk**: Transfer of water from the GUC to the reservoirs via pumps and pipelines presents a risk of biofouling by zebra mussel, which are present in the GUC but not in the reservoirs. Subsequently there is a risk of biofouling in the downstream connections to the GUC should zebra mussels be introduced to the reservoirs. Prevention of zebra mussel transfer is the best mitigation; however, there are mitigation options for biofouling, should that occur – see below.	**Medium Risk**: Transfer of water from the GUC to the reservoir via pumps and pipelines presents a risk of biofouling by zebra mussel, which are present in the GUC but not in the reservoir. Subsequently there is a risk of biofouling in the reservoir, pumps, and subsequent pipeline, should zebra mussels be introduced to the reservoir. Prevention of zebra mussel transfer is the best mitigation; however, there are mitigation options for biofouling, should that occur – see below.
Filtering of the reservoir water by mussels, Zebra Mussel,	**Low Risk**:	**Low Risk**:	**No Risk:**

[34] Holdich, D. M., Sibley, P. J. & Peay, S. (2004) The white-clawed crayfish - a decade on. British Wildlife 15, 153-164.
[35] https://www.nonnativespecies.org/non-native-species/information-portal/view/1250.

Potential impacts	Risk to Drayton Reservoir	Risk to Daventry Reservoir	Risk to Bletchley storage reservoir
Asian Clam and native mussels bringing about an ecosystem shift, e.g. favouring blue-green algae and risk of blooms.	Potential impact on Carp fishery and other species which could be negative or positive. The lack of Zebra Mussel is notable, given long standing local presence, potentially indicating conditions in the reservoir are not suitable for, at least, Zebra Mussel. The suitability of the reservoirs should be assessed with respect to water pH, turbidity, and presence of suitable substrate for colony formation.	Potential negative impacts on fishery (of less value than Drayton Reservoir). The same assessment, as with Drayton Reservoir, should be carried out.	As a new reservoir, there will be no native species present, and the reservoir will not function as a natural water body.
Predation on native species e.g. Demon Shrimp are predatory on native amphipods such as *Gammarus* and are likely to predate on a broader range of macroinvertebrates such as EPT, damselflies and chironomids[36].	**Medium Risk**: Alteration of reservoir ecology and indirect impact on fishery. However, habitat suitability, in the context of survivability with respect to carp predation, is unknown.	**Medium Risk**: Alteration of reservoir ecology and indirect impact on fishery. However, habitat suitability, in the context of survivability with respect to carp predation, is unknown.	**No Risk:** As a new reservoir, there will be no native species present, and the reservoir will not function as a natural water body.
Displacement and, or predation from fish species, e.g. Zander and Wels Catfish	**Low Risk**: The chances of fish from the GUC bypassing screening and surviving the pumping up into the reservoir is very low.	**Low Risk**: The chances of fish from the GUC bypassing screening and surviving the pumping up into the reservoir is very low.	**No Risk**: No fish present in the new reservoir. The chances of fish from the GUC bypassing screening and surviving the pumping up into the reservoir is very low.
Onward transfer of INNS from reservoir to receiving water bodies	**No Risk:** Downstream connection to GUC already exists, together with connection of GUC to receiving water bodies (headwaters of River Nene catchment)	**No Risk:** Downstream connection to GUC already exists, together with connection of GUC to receiving water bodies (headwaters of River Nene catchment)	**Low Risk:** No onward connections to receiving water bodies exist (pipeline transfer to treatment only). Risks of INNS transfer controlled by BMP and best-practise biosecurity measures.

Mitigation at Drayton and Daventry Reservoirs, and Bletchley Storage Reservoir

4.1.16 Table 4-3 summarises the potential mitigation options that could be implemented to prevent the spread of invasive non-native species into the reservoirs and, should they be found in one or other reservoir, how to eradicate them.

Table 4-3: Summary of potential mitigation options

Mitigation	Discussion
Position of inflow	The position of the abstraction from the canal should be carefully selected to minimise the potential for INNS to be drawn in. While options for optimising position are limited in the context of canals (versus reservoirs for example), positioning the abstraction tangentially at points of faster water movement, or away from slow water or vegetated margins, would be recommended.
Habitat management near inflow	Following on from the above, the canal should be managed in the area surrounding the abstraction, such that vegetation does not establish, or detritus does not accumulate.
Surveillance and control action near inflow	Propagule pressure is dependent on population size. As such, the l kelihood of spread into the two reservoirs is dependent on the size of populations in the GUC, specifically, in the section from which the water is abstracted. A list of

[36] Bollache, L., Dick, J.T.A., Farnsworth, K.D. and Montgomery, W.I. (2008) Comparison of the functional responses of invasive and native amphipods. BIOLOGY LETTERS 4, pp.166-169.

Mitigation	Discussion
	those species that might to be transferred up into the reservoirs has been provided, and should be updated through monitoring, and the relevant section of the GUC should be subject to regular surveillance. The list is likely to comprise just plants, as eradicating macroinvertebrates such as Zebra Mussel and American Signal Crayfish is not feasible, and the collateral environmental damage can be substantial. The occurrence of these listed INNS found should be subject to a rapid response with the aim of eradicating the INNS plant species from the abstraction section. Factors, such as limiting the risk of spread by carrying out control prior to seeding, and prevention of creation of small fragments, should be part of the rapid response. Surveillance should be both planned based on regular surveys by suitably qualified ecologists at fixed occasions, and opportune recording by members of the Trust, fishermen and possibly members of the general public. Immediate communication of any such records to the agency tasked with the rapid response would be essential.
Screens at inflow	While it is not possible to stop all life stages of all INNS by screening, while maintaining relevant rates of abstraction, the life stage that 'make it through' is relevant regarding survival, onward spread, and establishment. For example, the mortality rate of animal larval/juvenile stages is extremely high as they tend to be very vulnerable (e.g. Signal Crayfish moult approximately 11 times in their first year, but only once per year at full maturity – a moulted crustacean is very vulnerable to predation and physical damage). Additionally, it can take years for a larva to mature and become reproductive (allowing time for identification and rapid response, e.g. signal crayfish typically take 2 to 3 years to reach reproductive maturity and zebra mussels take 1 to 2 years). Killer Shrimp *Dikerogammarus villosus* (not currently present), on the other hand, can reach reproductive maturity within a couple of months.
Pumping	The pump(s) used to abstract water from the GUC into the reservoirs creates a hostile environment for many species. This is likely restricted to invasive non-native animals and potentially only the adults. Their eggs and larval stages, although suffering mortality, will likely on occasion retain viability after transfer. Invasive non-native plants may survive being pumped as they can grow from small fragments of stem and, where seeds or other propagules are produced some of these, too, will survive the conditions. An investigation into pump type and pressures reached, versus INNS survivability, would provide useful information, and could help inform water transfers here and elsewhere.
Position of outflow	The introduction of INNS and their establishment is not the same thing. As such, by creating as hostile an environment as possible near outflows, the potential of successful invasion can be reduced. At the reservoirs this could be achieved by piping the water transfer into the deepest part of the reservoir, necessitating the movement of propagules and animals into more favourable parts of the reservoir in order to survive, while simultaneously imposing limited resources to facilitate such movement and exposing them to predation or herbivory. This may not be feas ble when balanced with the requirement to attenuate inflows through e.g., cascades and water treatment / settlement areas before it enters the reservoirs, which may provide opportunities for habitat creation and Biodiversity Net Gain, whilst at the same time providing an opportunity for INNS to become established.
Barriers at outflow	Silt curtains, or similar, could be set back from outflows, allowing for small mesh/pore size (small enough to capture most, if not all life stages), but over an increased surface area (thus reducing/eliminating impacts on flow rate and clogging). The area within the silt netting could be monitored. Such 'screens' could be designed to prevent movement over or below the screen. Additionally, natural features such as reedbeds, shallows, or meanders could be used as 'biological nets' surrounding outflows and acting as points for enhanced surveillance (as per water treatment / settlement areas described above).
Surveillance and control action near outflow and in reservoirs	As for the sections of the GUC from which water will be abstracted, the reservoirs should be subject to surveillance. The list of species for which to search would be a comprehensive list of INNS that could be spread up into the reservoirs including macroinvertebrates such as Zebra Mussel and American Signal Crayfish. Surveillance should be both planned based on regular surveys by suitably qualified ecologists at fixed occasions and opportune recording by members of West Northamptonshire District Council (Daventry Reservoir only), the Trust, AfW operatives, fishermen and other members of the general public. Immediate communication of any such records to the agency tasked with the rapid response would be essential.

Mitigation	Discussion
	The nature of the rapid response will depend on the species identified. For invasive non-native plants, the response will be as for the section of GUC from which water is abstracted.
Biosecurity Management Plan BMP	Requirement for mitigation measures during construction, and surveillance and mitigation during operation, will be detailed in a BMP. This document should be updated regularly to consider evolving INNS risks and ensure current and best practise measures are employed to respond accordingly.

Biofouling of infrastructure at Drayton and Daventry Reservoirs and Bletchley Storage Reservoir

4.1.17 The most effective way to prevent biofouling is to prevent the introduction of zebra mussels (and other bivalves) in the first instance. Measures to support this are described above.

4.1.18 Should zebra mussels be transferred to the reservoirs, there is a risk of them causing biofouling of pumps, pipes, outlet valves, and other infrastructure[37]. The encrusting of infrastructure by zebra mussels and other bivalves can hinder operation and result in significant maintenance requirements and costs. Management methods can include chemical control, manual removal, mechanical removal, or biological control (the latter method being currently unproven)[40].

4.1.19 Further advice on the prevention of biofouling can be provided once the design of the abstraction from the canal, and infrastructure associated with the reservoirs, is confirmed.

Overview of impact of spread of INNS into Drayton and Daventry Reservoirs and Bletchley Storage Reservoir

4.1.20 Fish and adult crayfish are highly unlikely to spread into the reservoirs due to being unable to survive the pumps. Additionally, carp should act as a biological control agent for crayfish should they arrive, in particular in Drayton Reservoir.

4.1.21 Implementing the recommendations for mitigation above would reduce the risk of invasive non-native plants reaching the reservoirs and, even if any was transferred:

- there is low chance of establishment due to conditions in both reservoirs; and
- they would be picked up by surveillance of the reservoirs and could be controlled using a rapid response.

4.1.22 Aquatic macroinvertebrates could be spread into the reservoirs as eggs or juveniles, and this risk is hard to reliably mitigate. Were these species to establish themselves, the impacts could be significant, very significant for Drayton Reservoir given the potential to damage the carp fishery; less so for Daventry Reservoir, and significant in terms of operational risks to Bletchley storage reservoir. However, there are questions as to the suitability/survivability of the reservoirs to the INNS recorded nearby, given the apparent resilience of Drayton and Daventry Reservoirs to invasion. Bletchley storage reservoir is an entirely new water body and will serve purely as water storage prior to treatment and transfer by pipeline; therefore, the risk of onward INNS transfer is low.

4.2 Conclusions

4.2.1 The GUC acts as a dispersal corridor for INNS due the existing high level of connectivity between the different canal sections and associated rivers. It is important to ensure the scheme does not introduce new INNS to the GUC, due to the high potential for onward significant spread (if introductions were to occur). The only element of the SRO identified as presenting a risk of introduction to the GUC is accidental introduction during construction (i.e. during works to upgrade canal infrastructure to accommodate increased water volumes). However, the mitigation of such introductions is well understood and can be readily implemented using standard biosecurity methods. A Biosecurity Management Plan (BMP) should be produced for the scheme, which will mitigate this risk.

[37] https://invasivespeciesni.co.uk/wp-content/uploads/2021/09/Good_Practice_Management_-_Zebra_mussel-1.pdf

4.2.2 The potential that the increased volume of water moving through the canal network would (i) increase INNS spread through the network and/or (ii) create more favourable conditions within the network for INNS, was assessed. It was found, due to the proportionately minor changes to hydrology (from an INNS habitat preference perspective) and due to the mitigation measures that will be put in place to prevent negative hydrological consequence in general (e.g. raising canal banks and weirs), the changes in hydrology are unlikely to significantly modify INNS risk across the canal and river network.

4.2.3 Options for the proposed scheme include three new connections being created to three reservoirs, Daventry Reservoir, Drayton Reservoir, and the underground storage reservoir near Luton. Risks of INNS transfer exist during construction and operation.

4.2.4 Ultimate transfer of recycled water to the AfW drinking water network will be a hydrological ‘dead end’, with no realistic potential for INNS to be spread to the wild (or survive).

4.2.5 At a regional scale, transfers to Daventry and Drayton Reservoirs, and the underground storage reservoir near Luton, were found to have a low risk, as a relatively short ‘closed loop’ would be created. However, at a local scale the transfer of water from the GUC presents INNS risk to all reservoirs during construction and operation. The scale of this risk is difficult to quantify, as Daventry and Drayton Reservoirs appear to be resilient to invasion which could be due to both being constrained lacustrine habitats. However, should macroinvertebrates manage to establish, the carp fishery in Drayton Reservoir for example may be affected. There are several mitigation options available that will help reduce the risk to the reservoirs, with those that reduce propagule pressure and the probability of establishment being the most useful. Additionally, further investigations into (i) the suitability of the reservoirs to macroinvertebrates, and (ii) INNS survival through pumping infrastructure (once confirmed through the design), would help better quantify the risk.

4.2.6 INNS monitoring should be implemented to monitor the abstraction from the GUC to Daventry and Drayton Reservoirs, and the inflows into the reservoirs, for any invasion of INNS. The underground storage reservoir near Luton should also be monitored to assess operational risks. INNS plants (Himalayan balsam) and zebra mussels in particular, could lead to issues such as biofouling, which may necessitate further treatment and control. A comprehensive, routine monitoring programme using such innovations as eDNA and sniffer dogs will be an essential part of the Trust’s and AfW’s mitigation strategy for INNS and inform the working Biosecurity Management Plan (BMP), e.g. triggering off rapid responses.

Appendix A Figures – INNS Distribution

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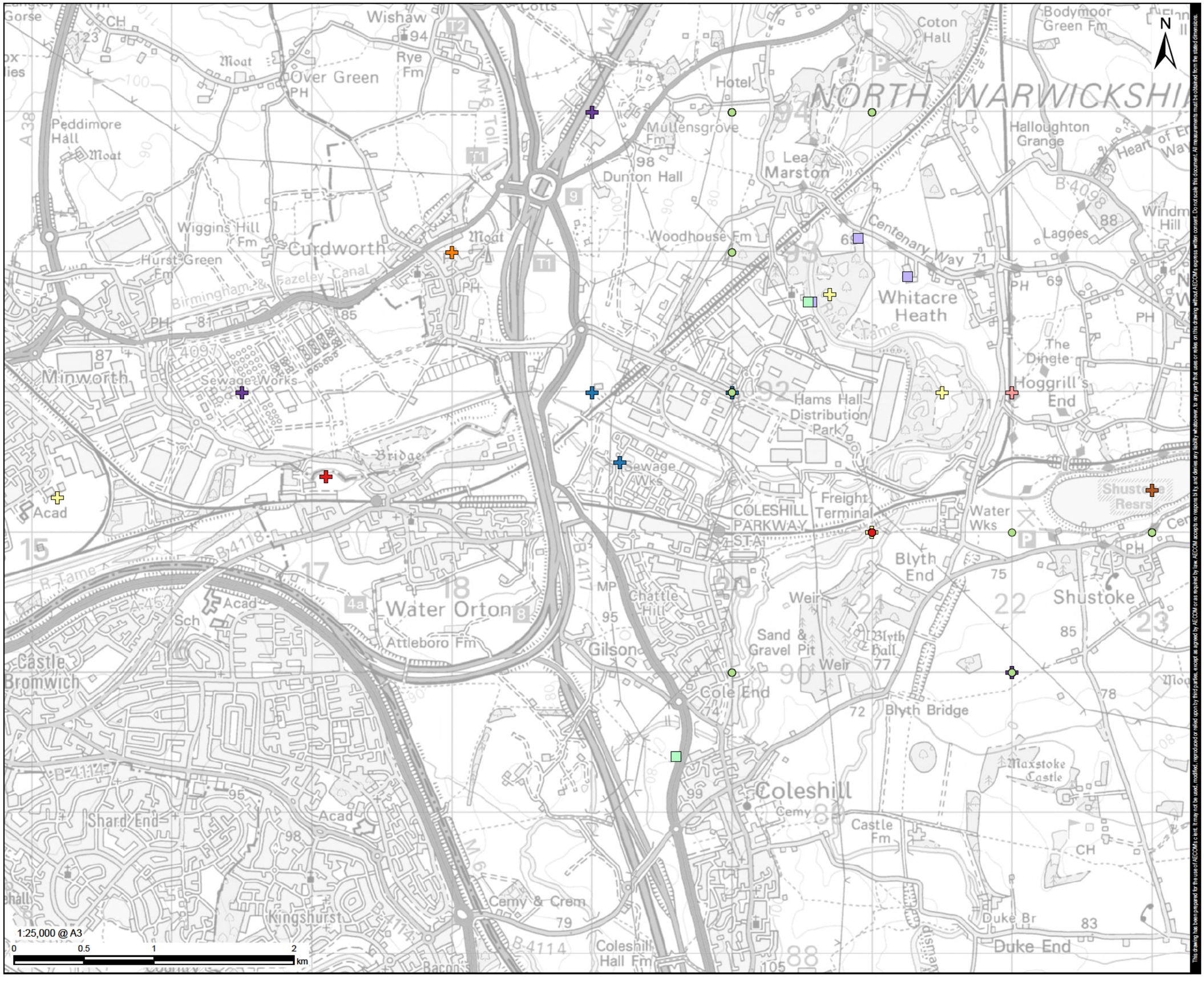

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PROJECT

Canal Transfer Route SRO
Gate 3

CLIENT

Affinity Water

CONSULTANT

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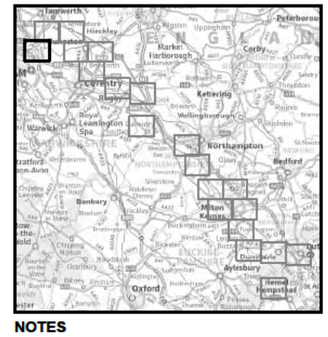
Midpoint
Alencon Link
Basingstoke, RG21 7PP
www.aecom.com

LEGEND

INNS Bird Species
- Canada Goose
- Mandarin Duck
- Red-crested Pochard

INNS Plant Species
- Giant Hogweed
- Himalayan Cotoneaster
- Japanese Rose
- New Zealand Pigmyweed
- Nuttall's Waterweed
- Rhododendron
- Wall Cotoneaster

INNS Terrestrial Mammal Species
- Chinese Muntjac
- Eastern Grey Squirrel



NOTES

ISSUE PURPOSE

FINAL

PROJECT NUMBER

60702564

FIGURE TITLE

Grand Union Canal
Invasive Non Native Species

FIGURE NUMBER

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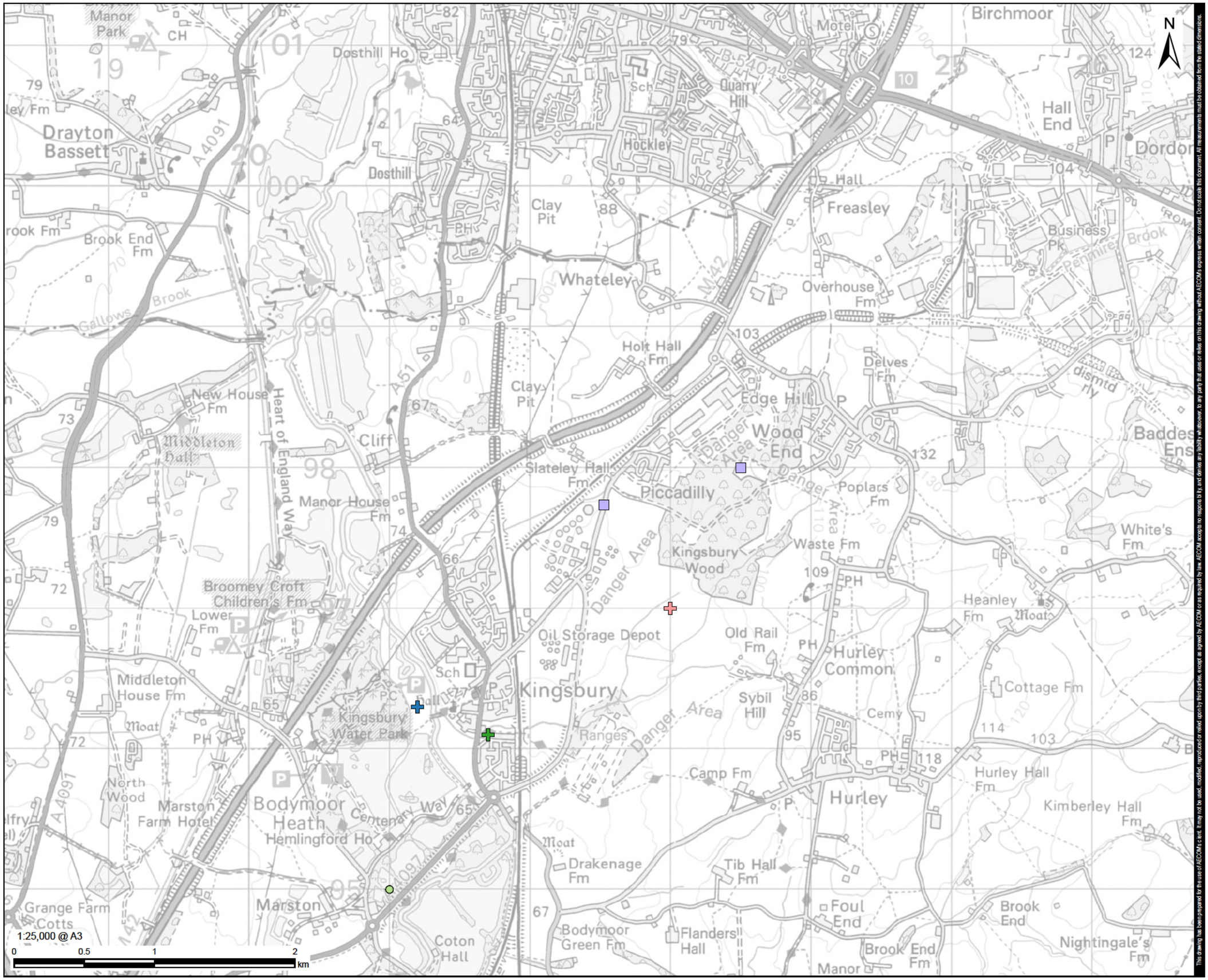

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LEGEND

INNS Bird Species
- Canada Goose

INNS Plant Species
- Canadian Waterweed
- Virginia-creeper
- Wall Cotoneaster

INNS Terrestrial Mammal Species
- Chinese Muntjac

NOTES

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FIGURE TITLE

Grand Union Canal
Invasive Non Native Species

FIGURE NUMBER

60702565-AW-GUC-000-INNS-1

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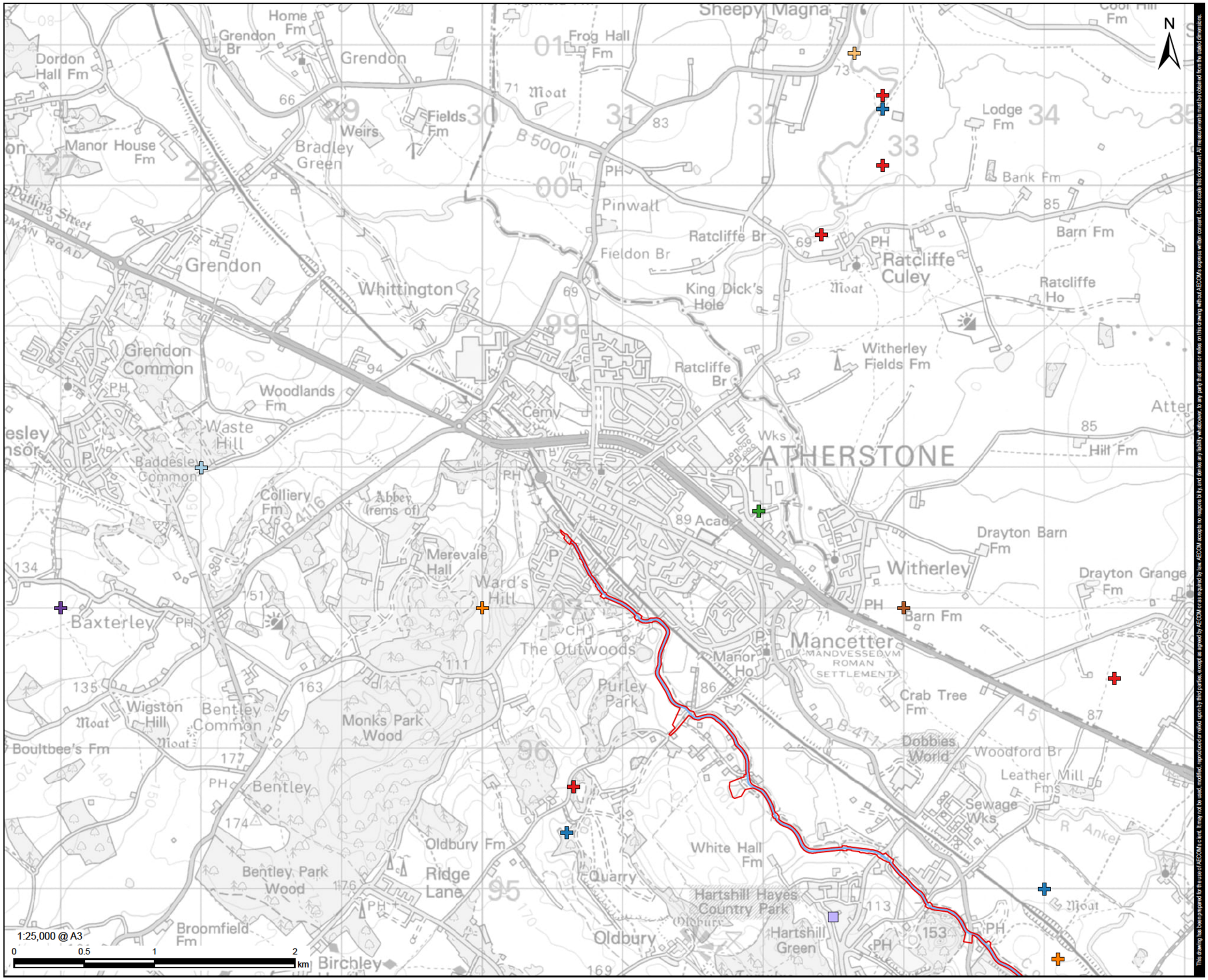

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LEGEND

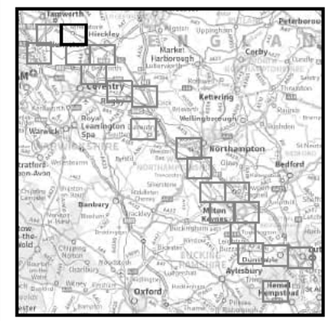
- Red Line Boundary
- Canal System

INNS Plant Species

- Canadian Waterweed
- Entire-leaved Cotoneaster
- Giant Hogweed
- Himalayan Balsam
- Himalayan Cotoneaster
- Japanese Rose
- Nuttall's Waterweed
- Parrot's-feather
- Rhododendron

INNS Terrestrial Mammal Species

- Chinese Muntjac



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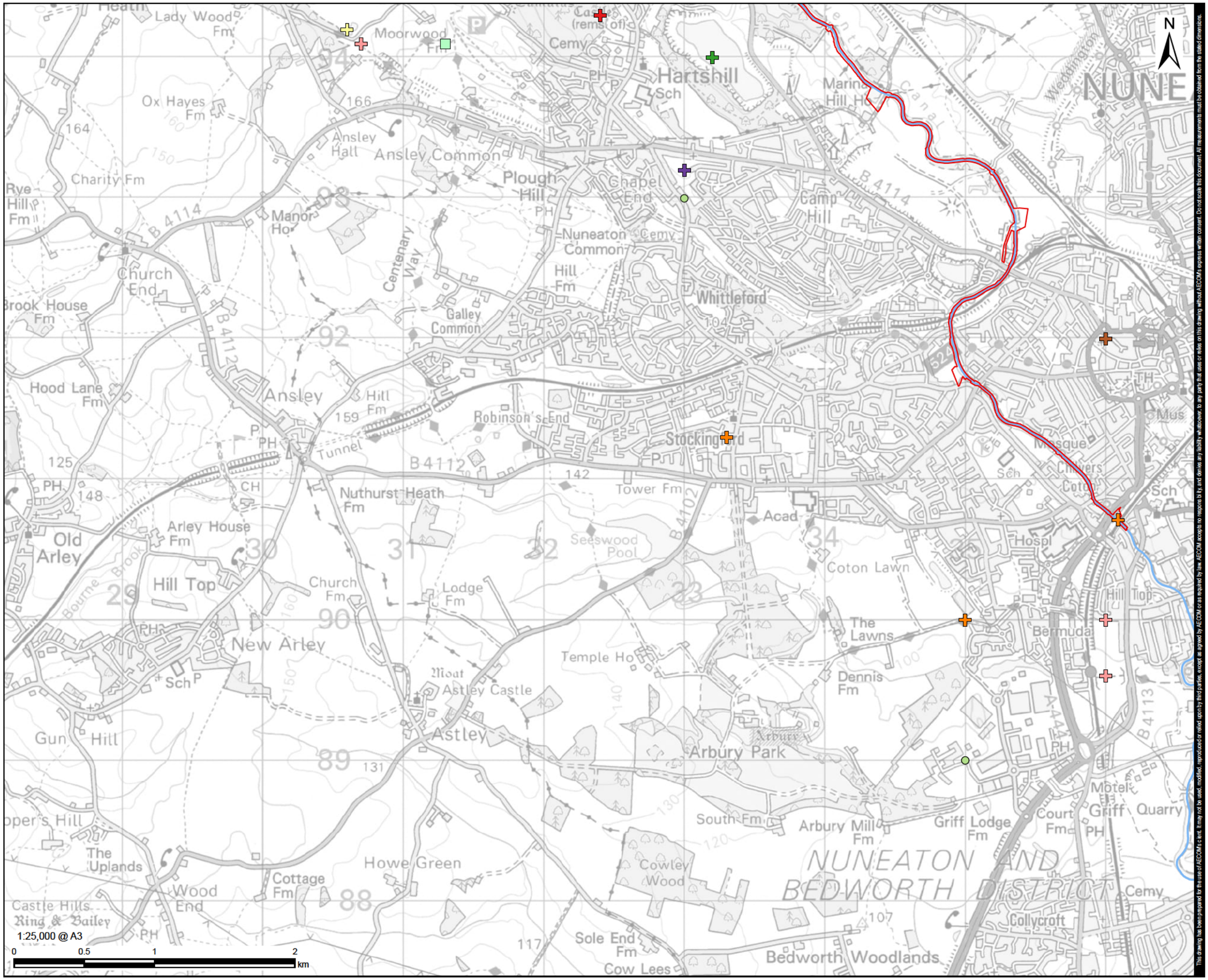

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LEGEND

- Red Line Boundary
- Canal System

INNS Bird Species

- Canada Goose

INNS Plant Species

- Few-flowered Garlic
- Giant Hogweed
- Himalayan Cotoneaster
- Japanese Rose
- New Zealand Pigmyweed
- Nuttall's Waterweed
- Virginia-creeper
- Wall Cotoneaster

INNS Terrestrial Mammal Species

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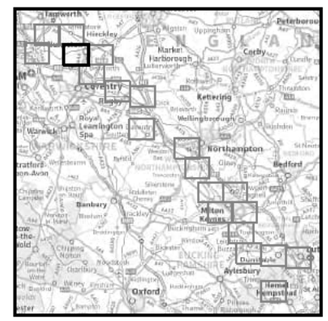
- Eastern Grey Squirrel



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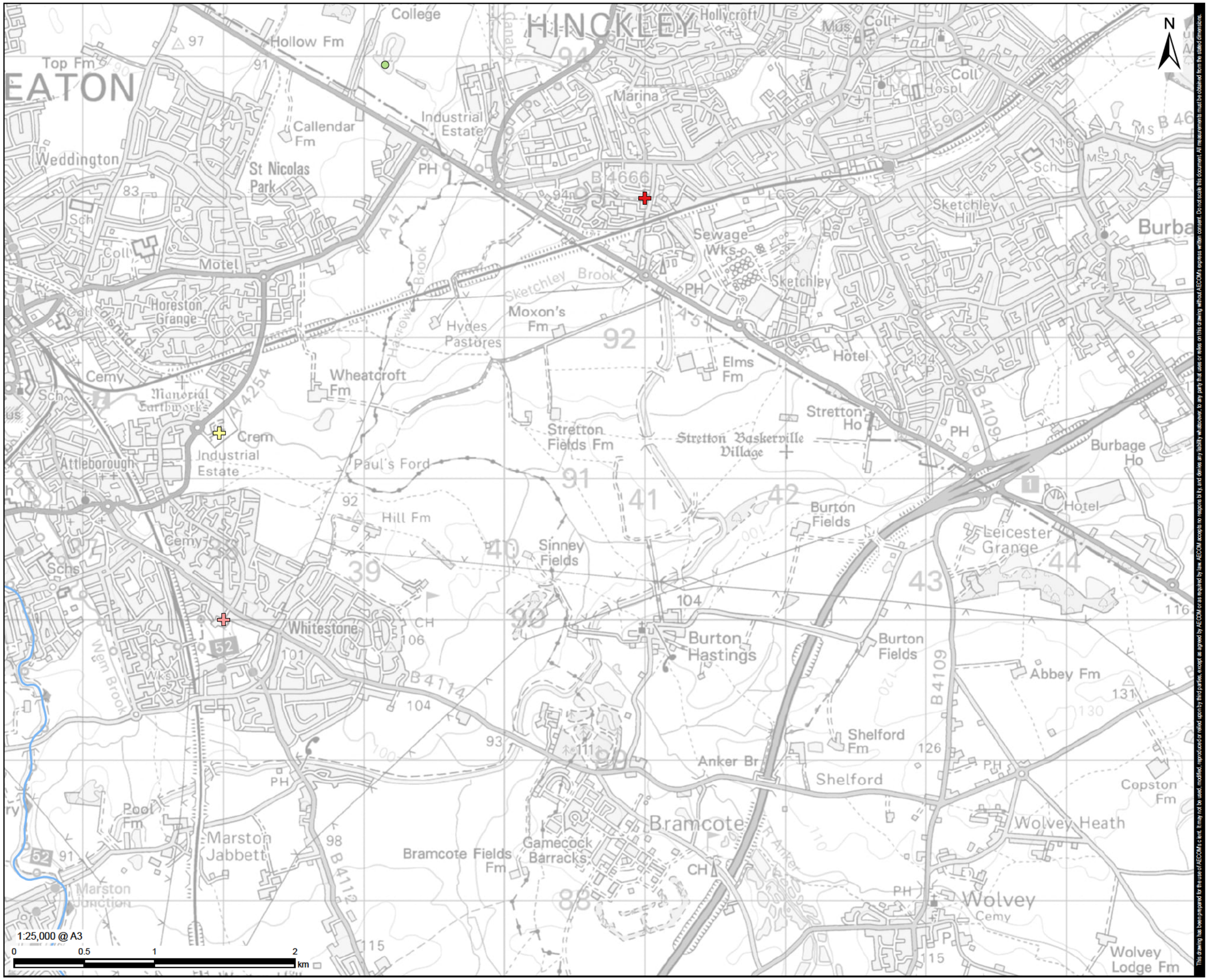

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LEGEND

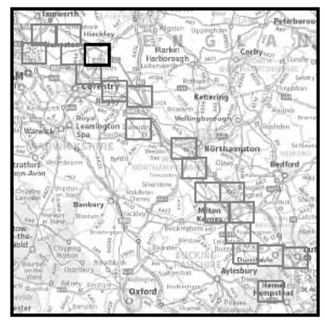
- Canal System

INNS Bird Species

- Canada Goose

INNS Plant Species

- Curly Waterweed
- Giant Hogweed
- New Zealand Pigmyweed
- Wall Cotoneaster



NOTES

ISSUE PURPOSE

FINAL

PROJECT NUMBER

60702564

FIGURE TITLE

Grand Union Canal
Invasive Non Native Species

FIGURE NUMBER

60702565-AW-GUC-000-INNS-1

Revision: 0 Drawn: OB Checked: JW Approved: JR Date: 2024-06-20

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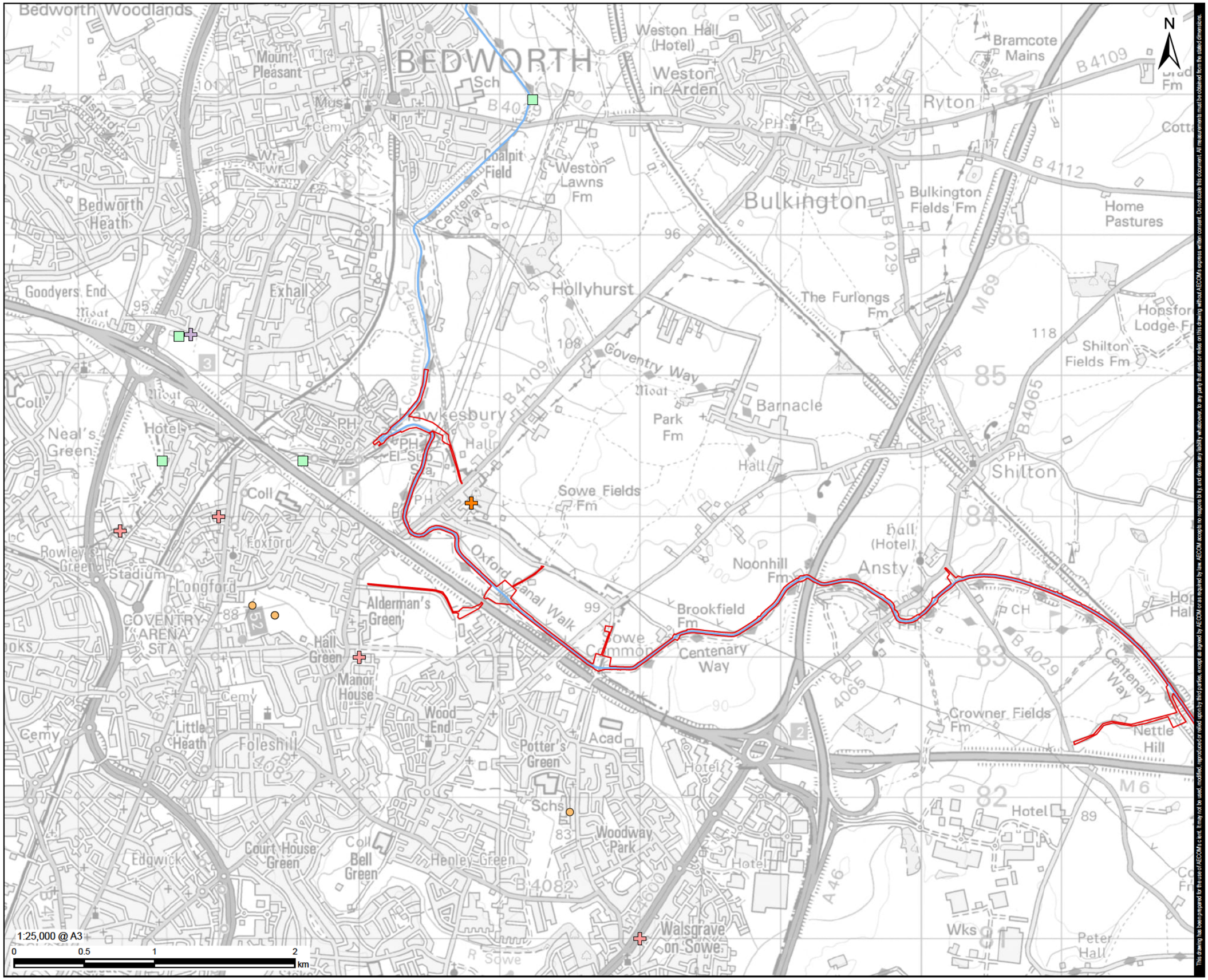


AECOM

PROJECT

Canal Transfer Route SRO
Gate 3

CLIENT

Affinity Water

CONSULTANT

AECOM Limited
Midpoint
Alencon Link
Basingstoke, RG21 7PP
www.aecom.com

LEGEND

- Red Line Boundary
- Canal System

INNS Bird Species

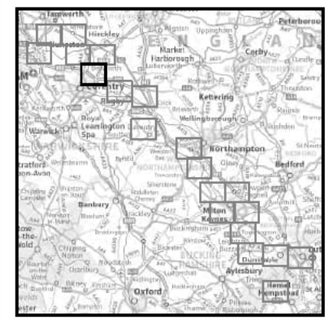
- Ring-necked Parakeet

INNS Plant Species

- Himalayan Cotoneaster
- Hollyberry Cotoneaster
- Wall Cotoneaster

INNS Terrestrial Mammal Species

- Eastern Grey Squirrel



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ISSUE PURPOSE

FINAL

PROJECT NUMBER

60702564

FIGURE TITLE

Grand Union Canal
Invasive Non Native Species

FIGURE NUMBER

60702565-AW-GUC-000-INNS-1

Revision: 0 Drawn: OB Checked: JW Approved: JR Date: 2024-06-20

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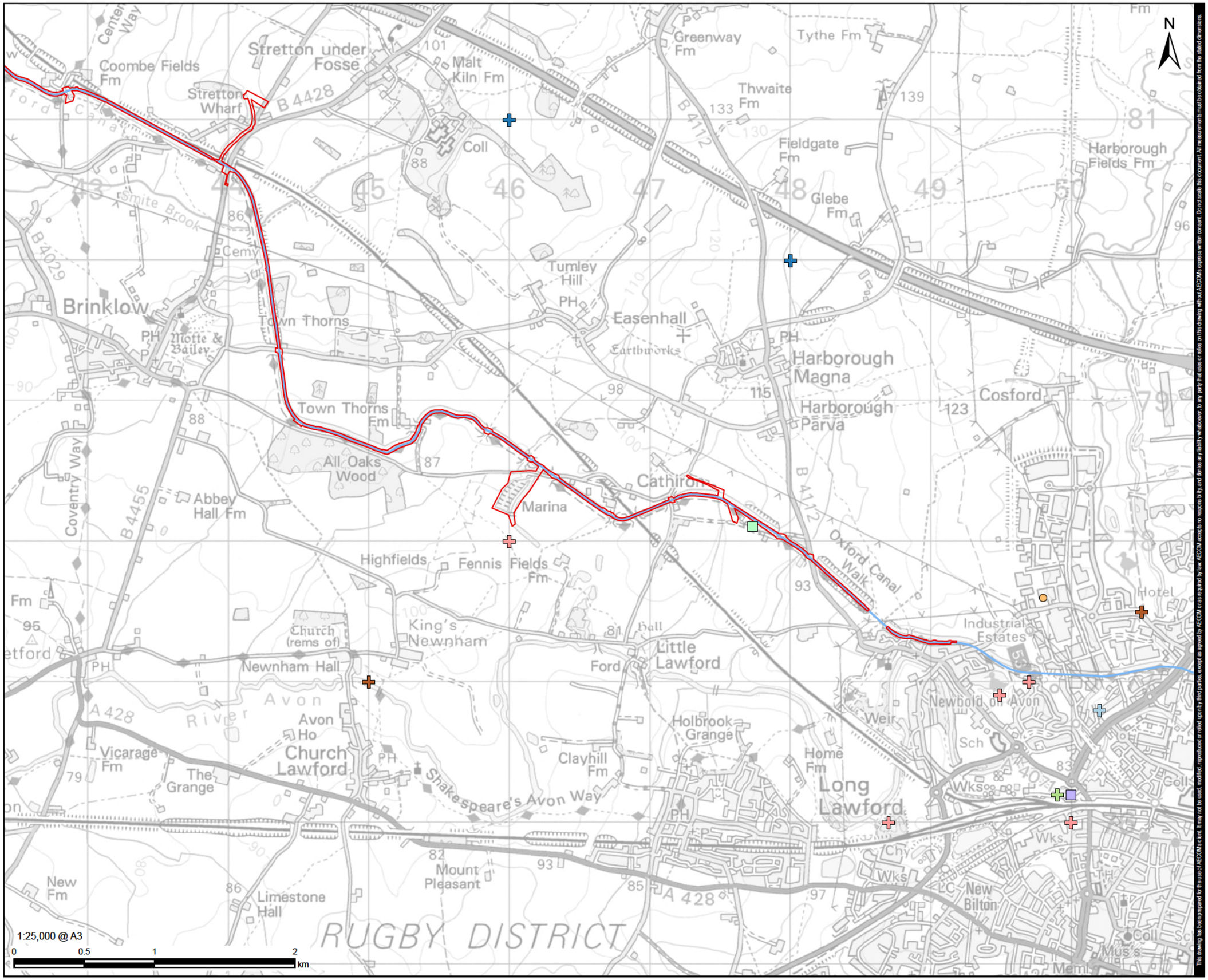

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Canal Transfer Route SRO
Gate 3

CLIENT

Affinity Water

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AECOM Limited
Midpoint
Alencon Link
Basingstoke, RG21 7PP
www.aecom.com

LEGEND

- Red Line Boundary
- Canal System

INNS Bird Species

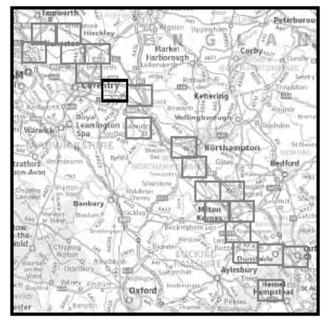
- Ring-necked Parakeet

INNS Plant Species

- American Skunk-cabbage
- Hollyberry Cotoneaster
- Nuttall's Waterweed
- Rhododendron
- Small-leaved Cotoneaster
- Wall Cotoneaster

INNS Terrestrial Mammal Species

- Chinese Muntjac
- Eastern Grey Squirrel



NOTES

ISSUE PURPOSE

FINAL

PROJECT NUMBER

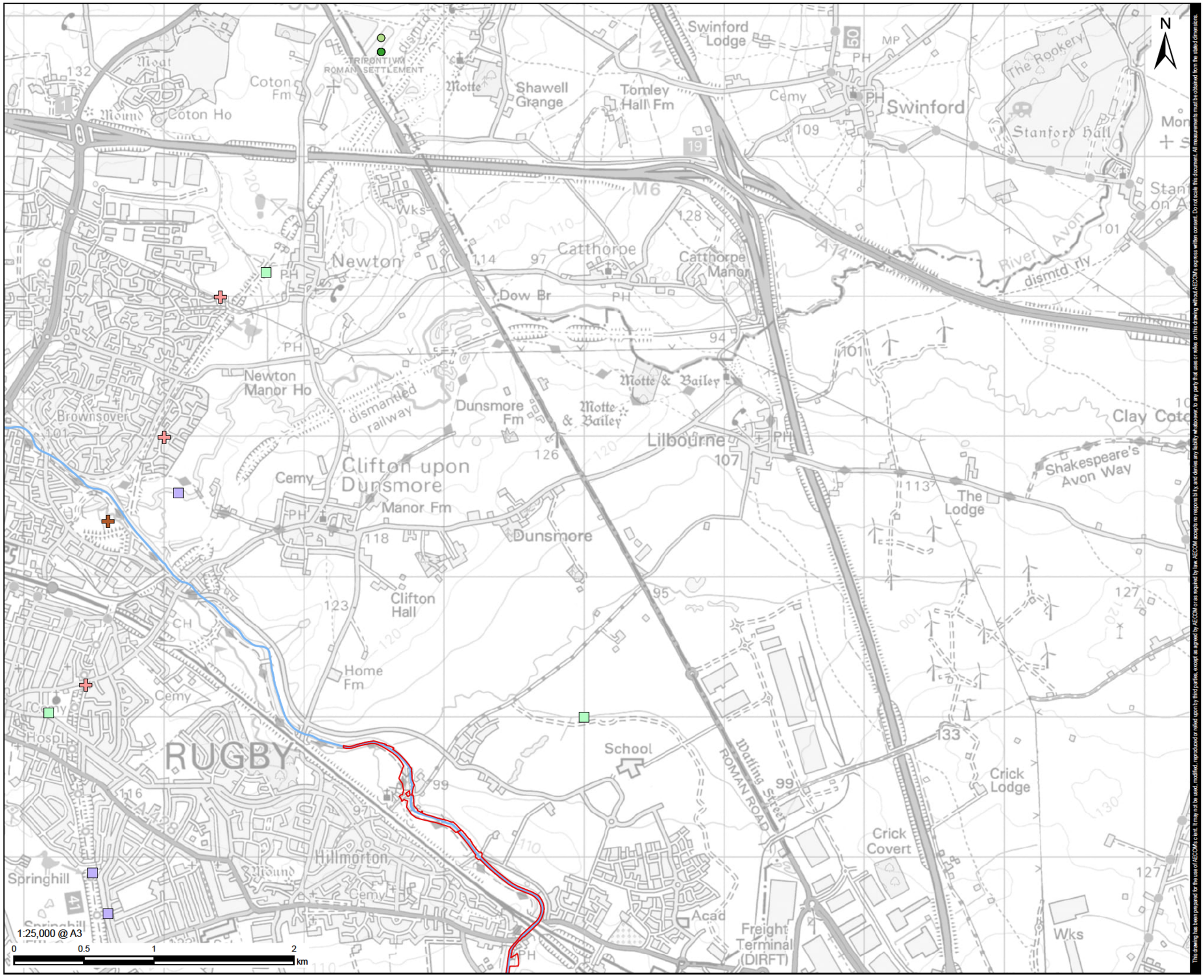
60702564

FIGURE TITLE

Grand Union Canal
Invasive Non Native Species

FIGURE NUMBER

60702565-AW-GUC-000-INNS-1



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Canal Transfer Route SRO
Gate 3

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Midpoint
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Basingstoke, RG21 7PP
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LEGEND

- Red Line Boundary
- Canal System

INNS Bird Species

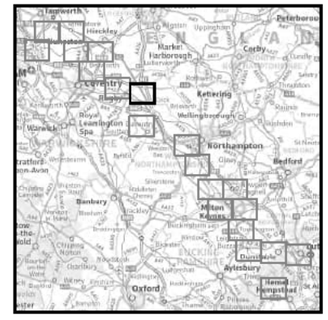
- Canada Goose
- Egyptian Goose

INNS Plant Species

- Nuttall's Waterweed
- Wall Cotoneaster

INNS Terrestrial Mammal Species

- Chinese Muntjac
- Eastern Grey Squirrel



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ISSUE PURPOSE

FINAL

PROJECT NUMBER

60702564

FIGURE TITLE

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Invasive Non Native Species

FIGURE NUMBER

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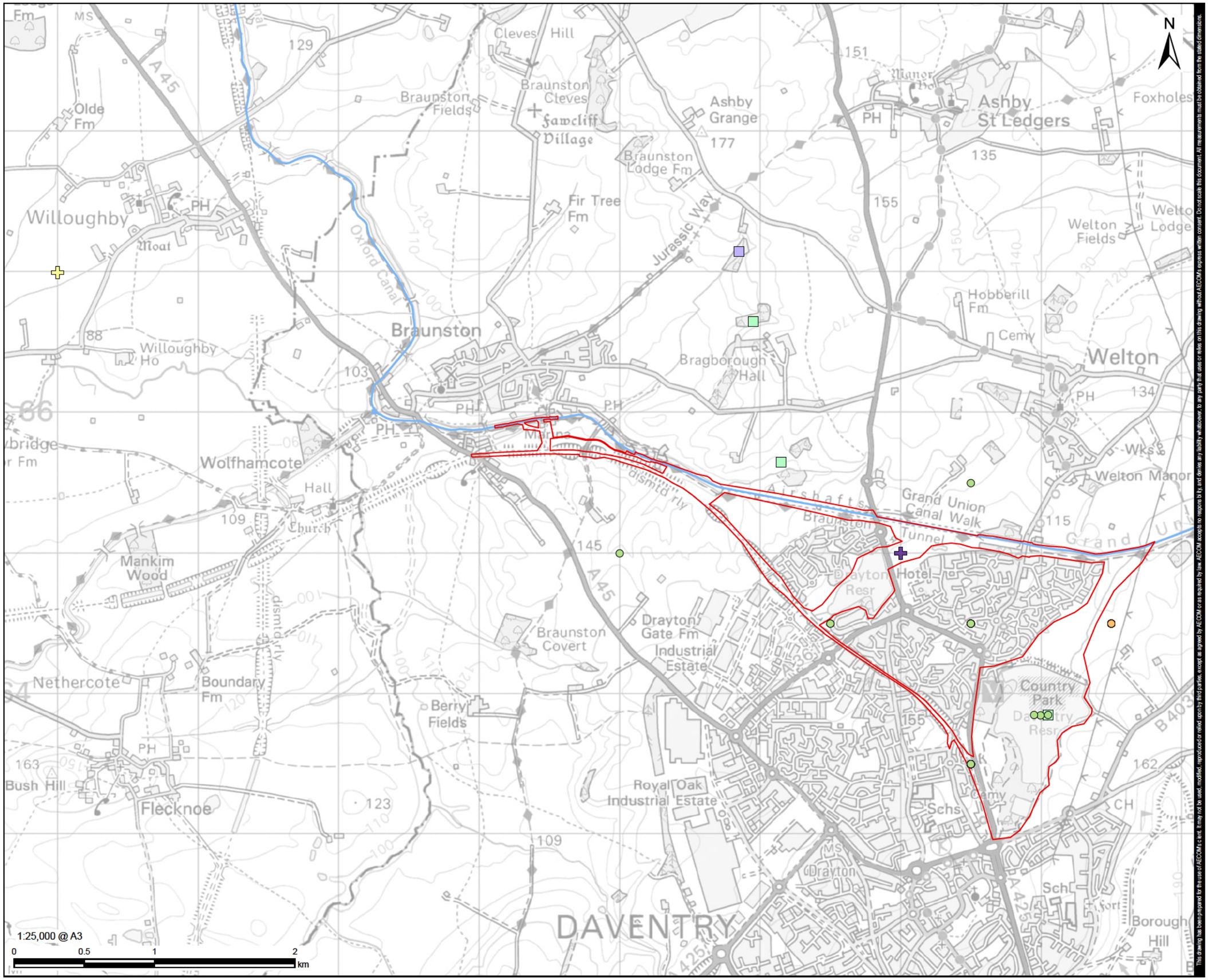

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Canal Transfer Route SRO
Gate 3

CLIENT

Affinity Water

CONSULTANT

AECOM Limited
Midpoint
Alencon Link
Basingstoke, RG21 7PP
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LEGEND

- Red Line Boundary
- Canal System

INNS Bird Species

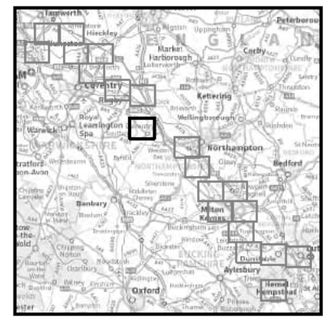
- Canada Goose
- Egyptian Goose
- Mandarin Duck
- Red-crested Pochard
- Ring-necked Parakeet

INNS Plant Species

- Japanese Rose
- New Zealand Pigmyweed

INNS Terrestrial Mammal Species

- Chinese Muntjac
- Eastern Grey Squirrel



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ISSUE PURPOSE

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PROJECT NUMBER

60702564

FIGURE TITLE

Grand Union Canal
Invasive Non Native Species

FIGURE NUMBER

60702565-AW-GUC-000-INNS-1

Revision: 0 Drawn: OB Checked: JW Approved: JR Date: 2024-06-20

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Canal Transfer Route SRO
Gate 3

CLIENT

Affinity Water

CONSULTANT

AECOM Limited
Midpoint
Alencon Link
Basingstoke, RG21 7PP
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LEGEND

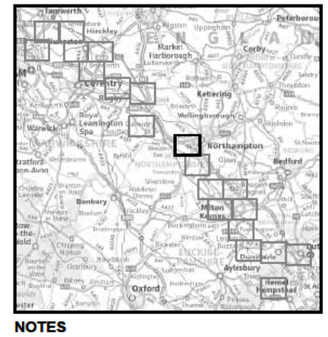
- Red Line Boundary
- Canal System

INNS Bird Species

- Canada Goose
- Red-crested Pochard

INNS Plant Species

- Himalayan Balsam



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ISSUE PURPOSE

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PROJECT NUMBER

60702564

FIGURE TITLE

Grand Union Canal
Invasive Non Native Species

FIGURE NUMBER

60702565-AW-GUC-000-INNS-1

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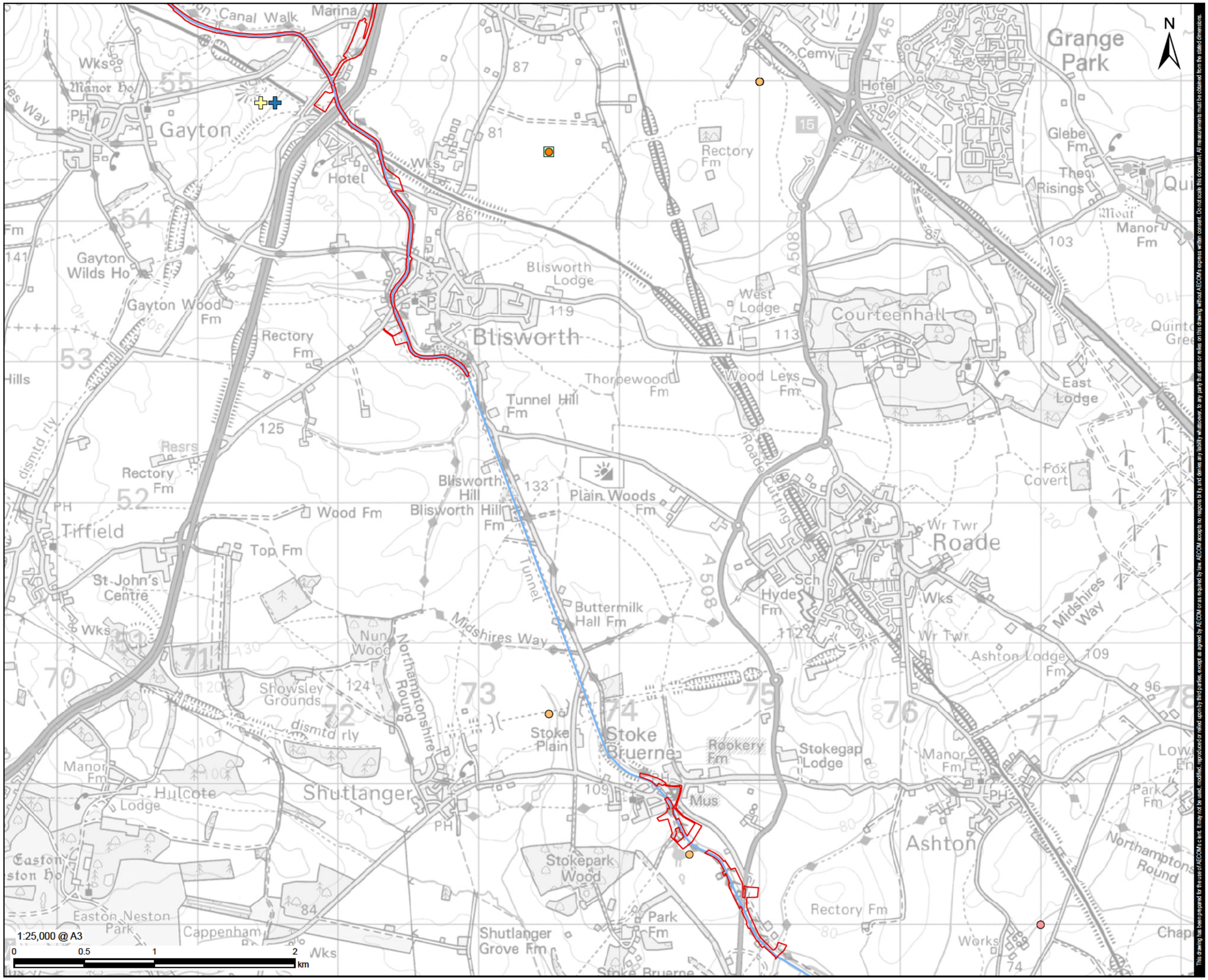

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PROJECT

Canal Transfer Route SRO
Gate 3

CLIENT

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Alencon Link
Basingstoke, RG21 7PP
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LEGEND

- Red Line Boundary
- Canal System

INNS Bird Species

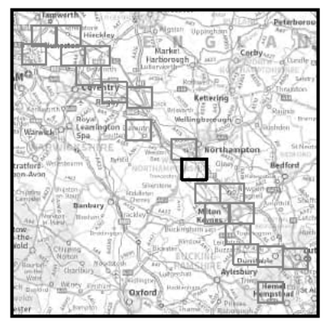
- Bar-headed Goose
- Canada Goose
- Egyptian Goose
- Mandarin Duck
- Red-crested Pochard
- Ring-necked Parakeet
- Wood Duck

INNS Plant Species

- Canadian Waterweed
- New Zealand Pigmyweed

INNS Terrestrial Mammal Species

- Eastern Grey Squirrel



NOTES

ISSUE PURPOSE

FINAL

PROJECT NUMBER

60702564

FIGURE TITLE

Grand Union Canal
Invasive Non Native Species

FIGURE NUMBER

60702565-AW-GUC-000-INNS-1

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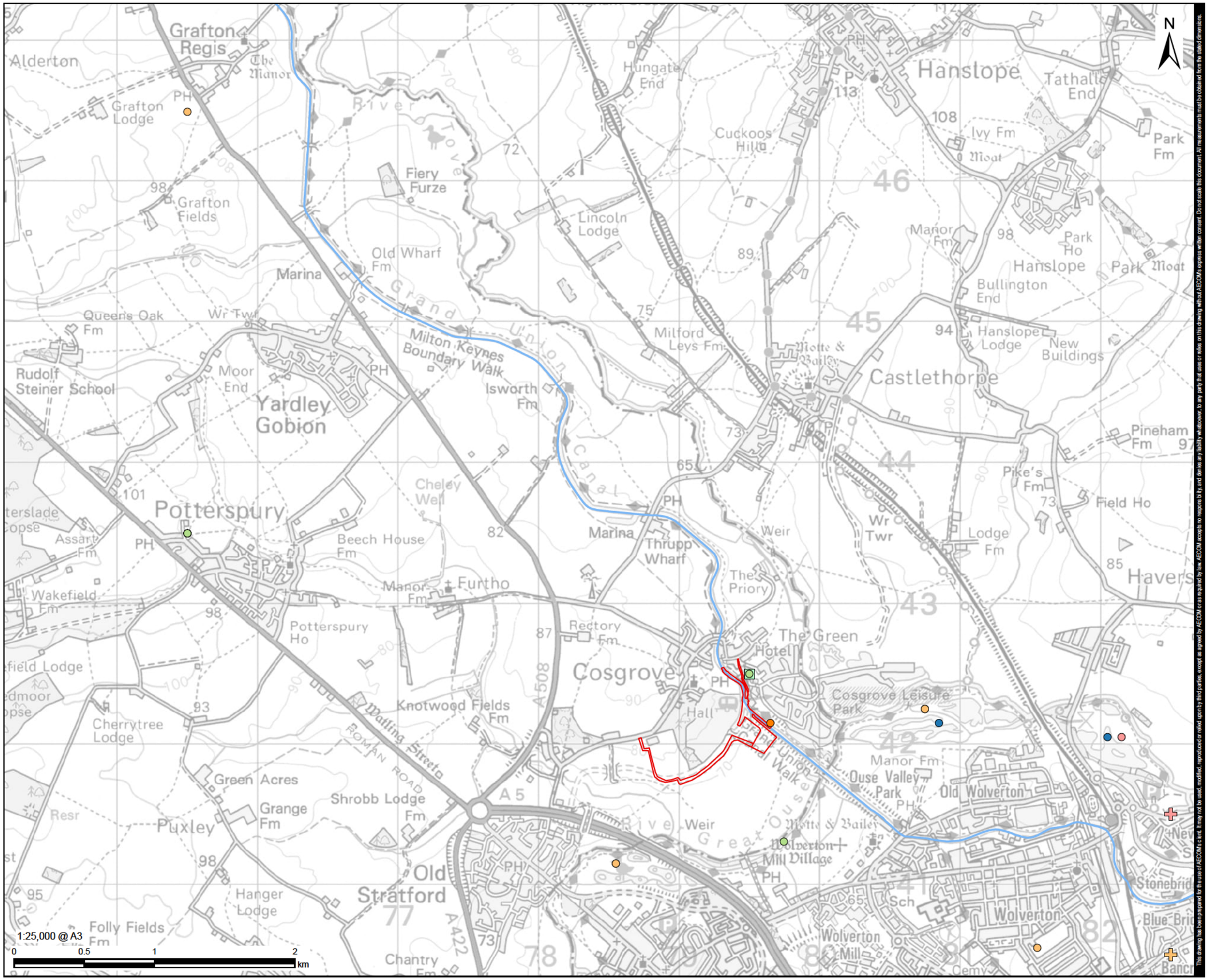

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PROJECT

Canal Transfer Route SRO
Gate 3

CLIENT

Affinity Water

CONSULTANT

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Midpoint
Alencon Link
Basingstoke, RG21 7PP
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LEGEND

- Red Line Boundary
- Canal System

INNS Bird Species

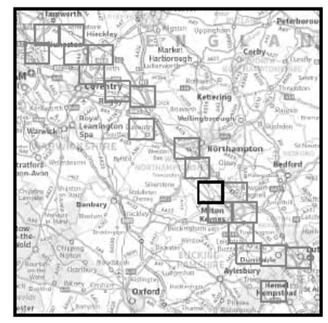
- Bar-headed Goose
- Black Swan
- Canada Goose
- Mandarin Duck
- Ring-necked Parakeet
- Wood Duck

INNS Plant Species

- Himalayan Balsam
- Wall Cotoneaster

INNS Terrestrial Mammal Species

- Eastern Grey Squirrel



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ISSUE PURPOSE

FINAL

PROJECT NUMBER

60702564

FIGURE TITLE

Grand Union Canal
Invasive Non Native Species

FIGURE NUMBER

60702565-AW-GUC-000-INNS-1

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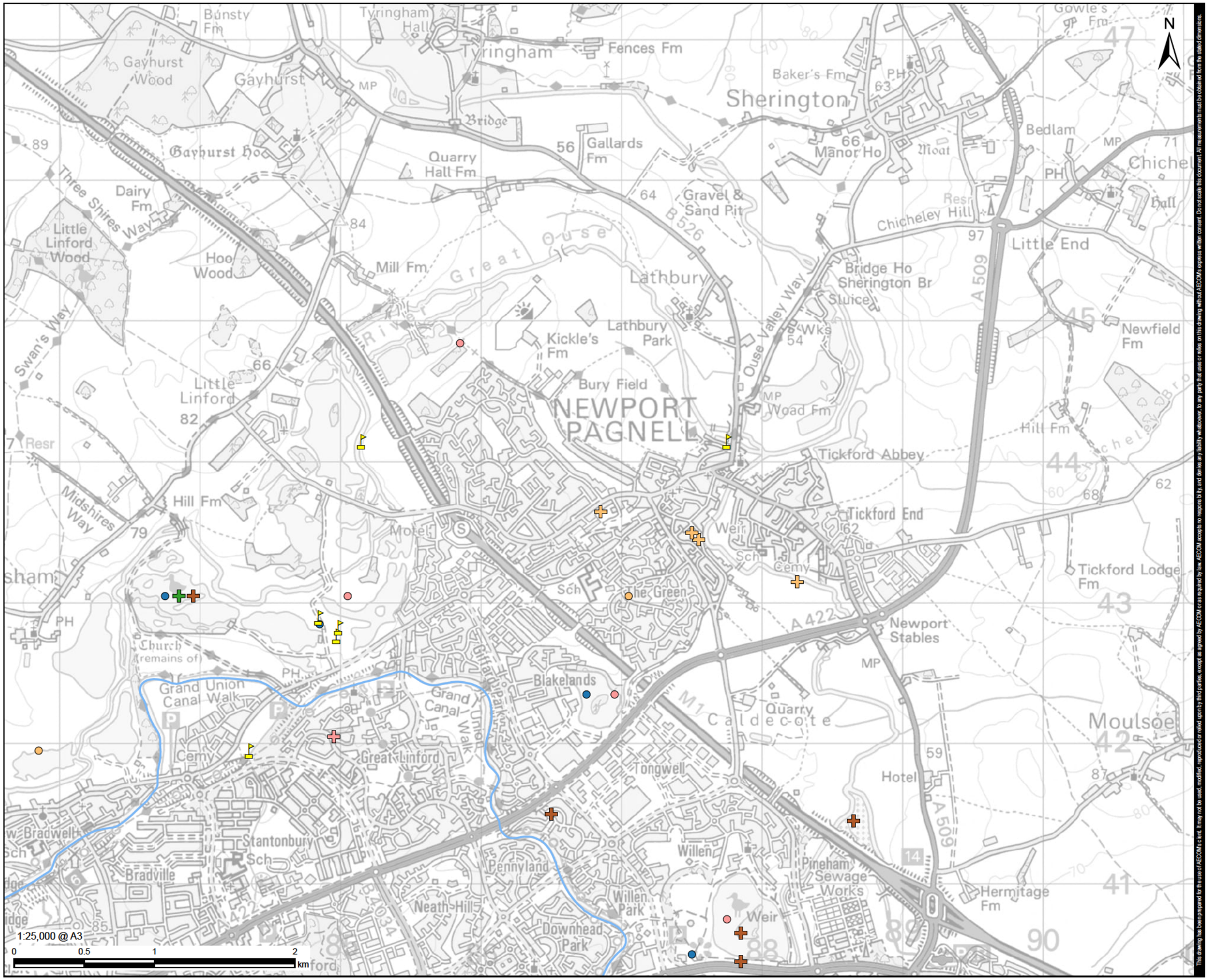

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PROJECT

Canal Transfer Route SRO
Gate 3

CLIENT

Affinity Water

CONSULTANT

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Alencon Link
Basingstoke, RG21 7PP
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LEGEND

- Canal System

INNS Invertebrate Species

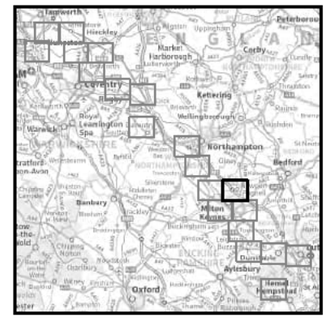
- Signal Crayfish

INNS Bird Species

- Black Swan
- Mandarin Duck
- Ring-necked Parakeet

INNS Plant Species

- Few-flowered Garlic
- Himalayan Balsam
- New Zealand Pigmyweed
- Nuttall's Waterweed
- Virginia-creeper



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ISSUE PURPOSE

FINAL

PROJECT NUMBER

60702564

FIGURE TITLE

Grand Union Canal
Invasive Non Native Species

FIGURE NUMBER

60702565-AW-GUC-000-INNS-1

AECOM

PROJECT

Canal Transfer Route SRO
Gate 3

CLIENT

Affinity Water

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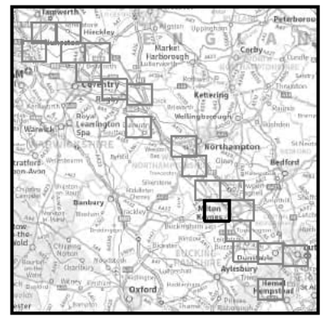
AECOM Limited
Midpoint
Alencon Link
Basingstoke, RG21 7PP
www.aecom.com

LEGEND

INNS Bird Species
- Mandarin Duck
- Ring-necked Parakeet

INNS Plant Species
- Himalayan Balsam
- Japanese Rose
- Nuttall's Waterweed
- Wall Cotoneaster

INNS Terrestrial Mammal Species
- Black Rat



NOTES

ISSUE PURPOSE

FINAL

PROJECT NUMBER

60702564

FIGURE TITLE

Grand Union Canal
Invasive Non Native Species

FIGURE NUMBER

60702565-AW-GUC-000-INNS-1

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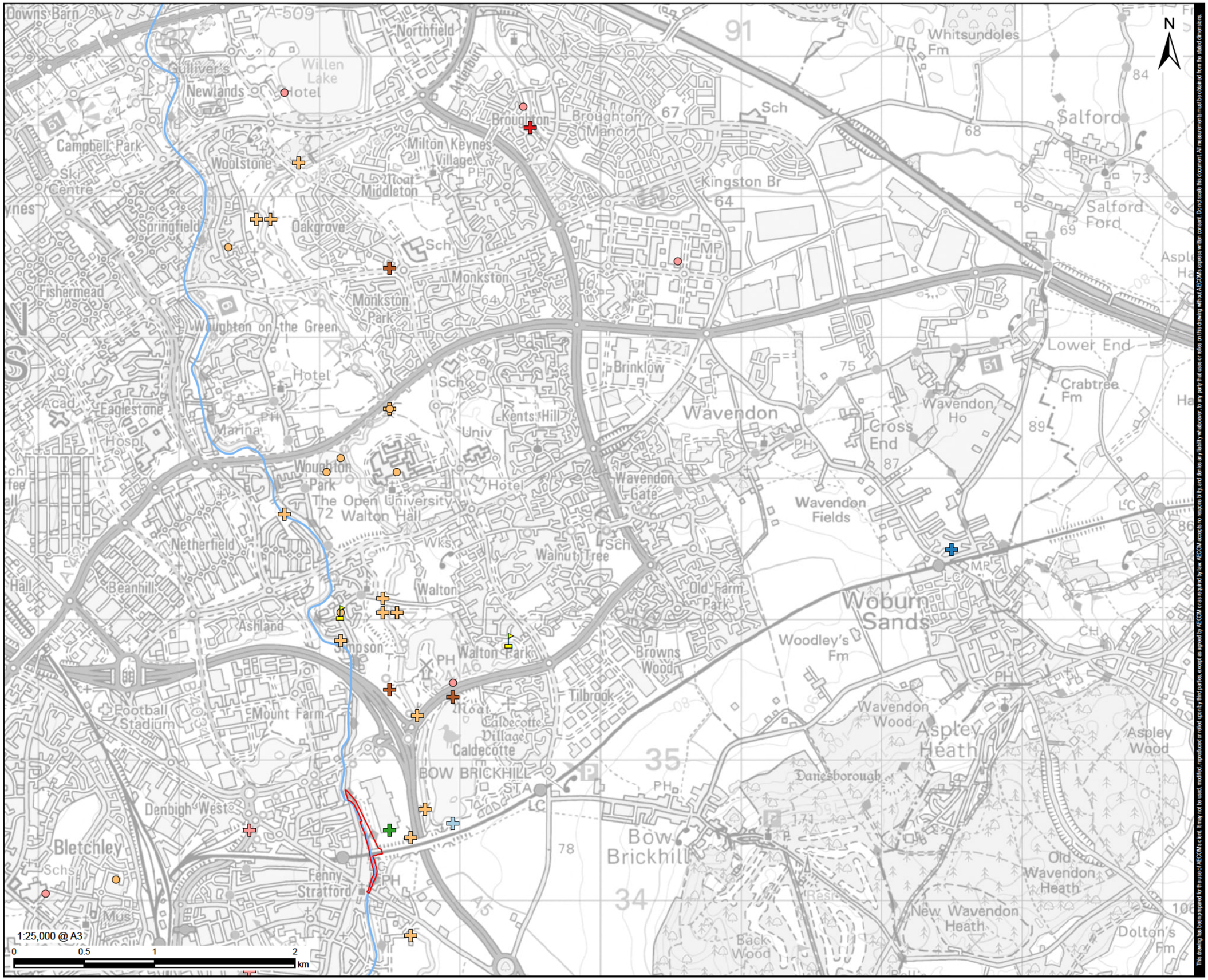

AECOM

PROJECT

Canal Transfer Route SRO
Gate 3

CLIENT

Affinity Water

CONSULTANT

AECOM Limited
Midpoint
Alencon Link
Basingstoke, RG21 7PP
www.aecom.com

LEGEND

- Red Line Boundary
- Canal System

INNS Invertebrate Species

- Signal Crayfish

INNS Bird Species

- Black Swan
- Mandarin Duck
- Ring-necked Parakeet

INNS Plant Species

- Canadian Waterweed
- Giant Hogweed
- Himalayan Balsam
- Japanese Rose
- Nuttall's Waterweed
- Parrot's-feather
- Virginia-creeper
- Wall Cotoneaster

NOTES

ISSUE PURPOSE

FINAL

PROJECT NUMBER

60702564

FIGURE TITLE

Grand Union Canal
Invasive Non Native Species

FIGURE NUMBER

60702565-AW-GUC-000-INNS-1

Revision: 0 Drawn: OB Checked: JW Approved: JR Date: 2024-06-20

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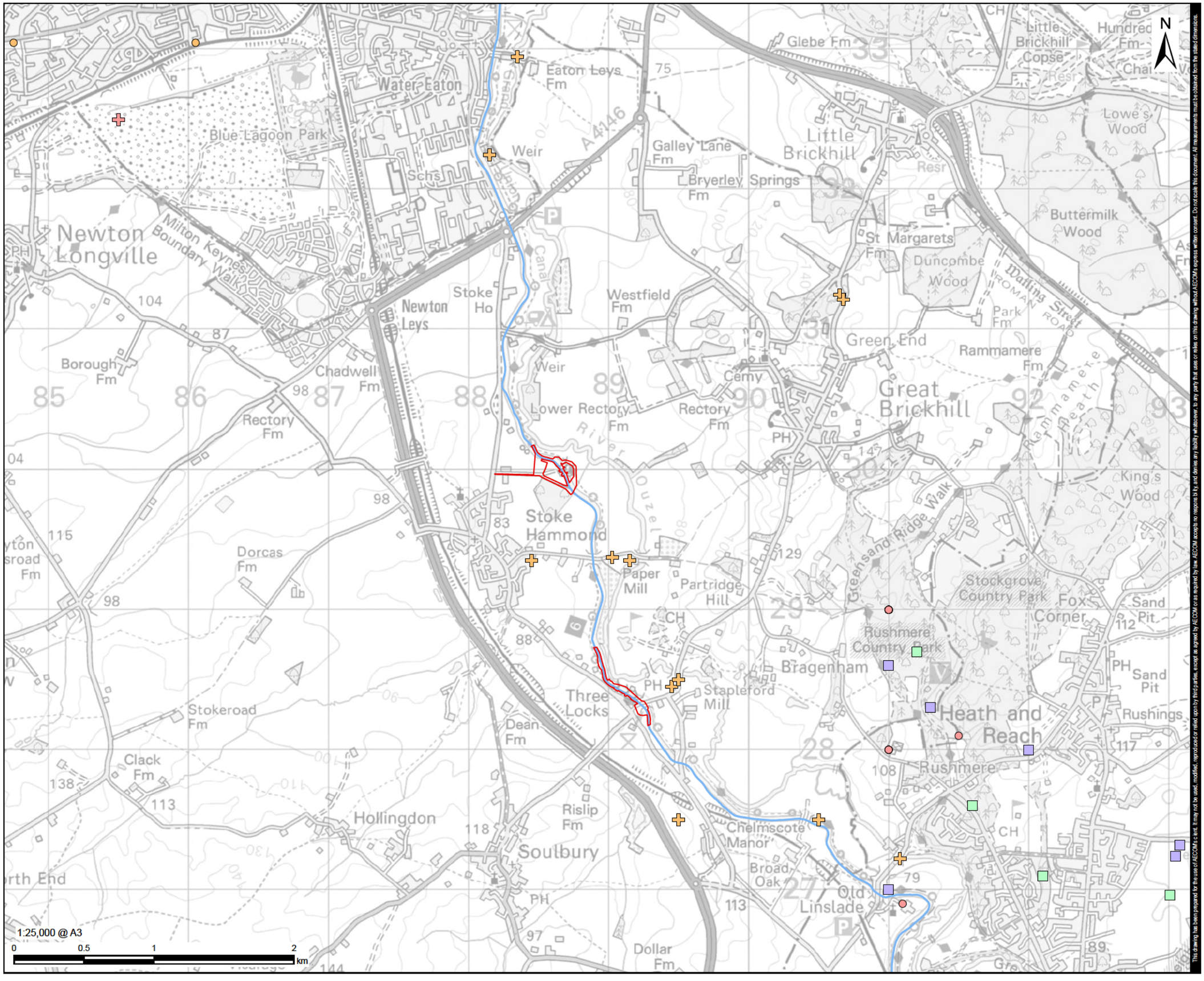

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PROJECT

Canal Transfer Route SRO
Gate 3

CLIENT

Affinity Water

CONSULTANT

AECOM Limited
Midpoint
Alencon Link
Basingstoke, RG21 7PP
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LEGEND

- Red Line Boundary
- Canal System

INNS Bird Species

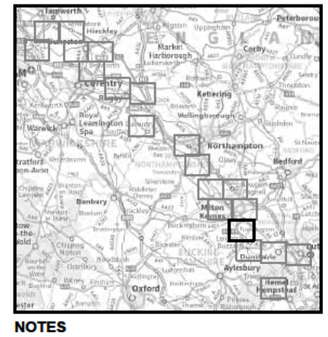
- Canada Goose
- Mandarin Duck
- Ring-necked Parakeet

INNS Plant Species

- Himalayan Balsam
- New Zealand Pigmyweed
- Wall Cotoneaster

INNS Terrestrial Mammal Species

- Chinese Muntjac
- Eastern Grey Squirrel



NOTES

ISSUE PURPOSE

FINAL

PROJECT NUMBER

60702564

FIGURE TITLE

Grand Union Canal
Invasive Non Native Species

FIGURE NUMBER

60702565-AW-GUC-000-INNS-1

Revision: 0 Drawn: OB Checked: JW Approved: JR Date: 2024-06-20

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Canal Transfer Route SRO
Gate 3

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Affinity Water

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Midpoint
Alencon Link
Basingstoke, RG21 7PP
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LEGEND

- Red Line Boundary
- Canal System

INNS Bird Species

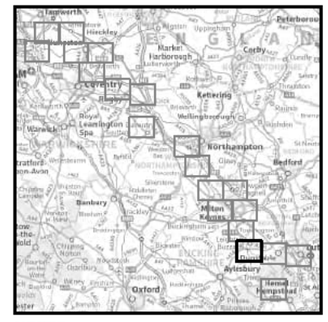
- Bar-headed Goose
- Black Swan
- Canada Goose
- Egyptian Goose
- Mandarin Duck
- Red-crested Pochard
- Ring-necked Parakeet

INNS Plant Species

- New Zealand Pigmyweed
- Nuttall's Waterweed

INNS Terrestrial Mammal Species

- Chinese Muntjac
- Eastern Grey Squirrel



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ISSUE PURPOSE

FINAL

PROJECT NUMBER

60702564

FIGURE TITLE

Grand Union Canal
Invasive Non Native Species

FIGURE NUMBER

60702565-AW-GUC-000-INNS-1

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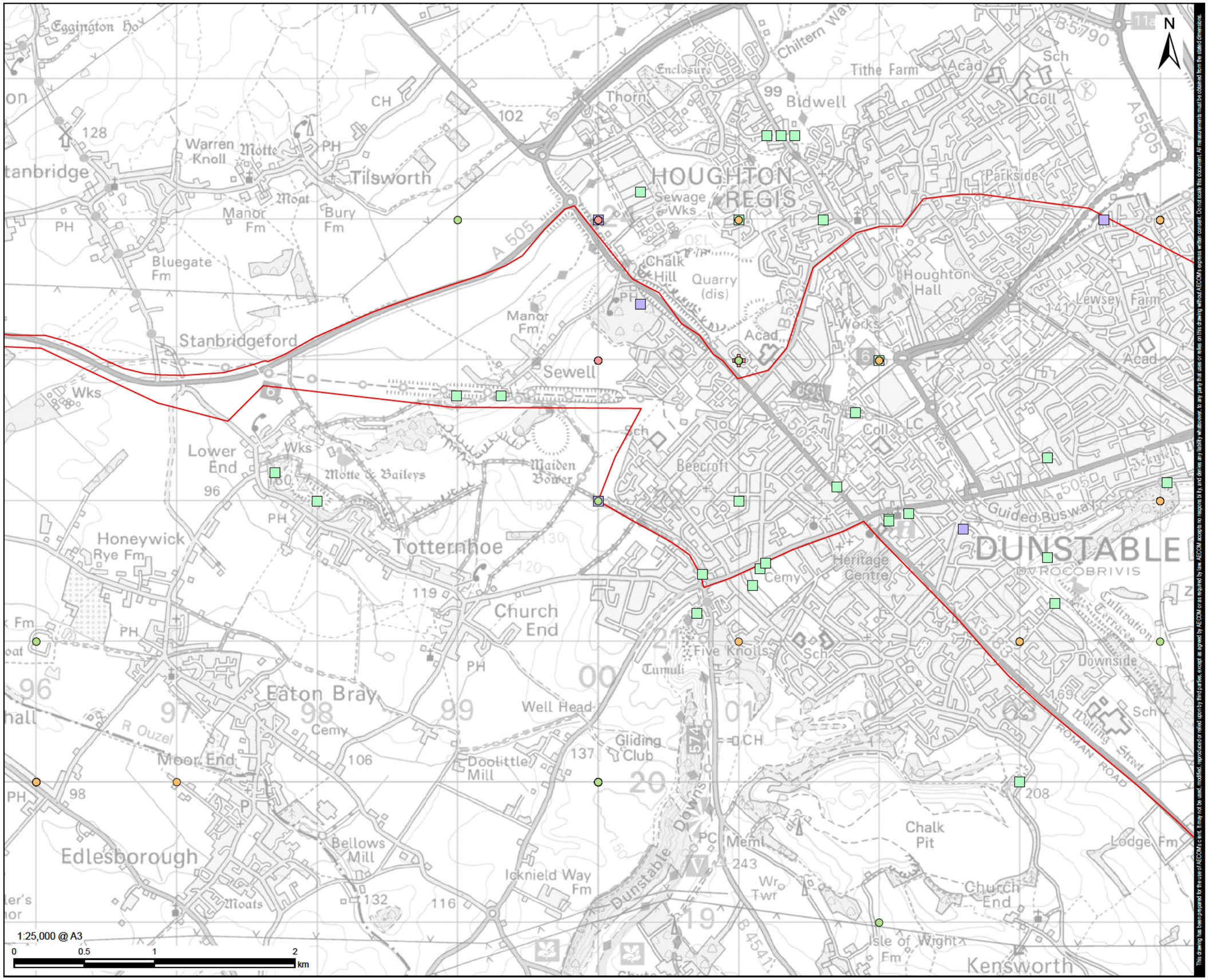

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PROJECT

Canal Transfer Route SRO
Gate 3

CLIENT

Affinity Water

CONSULTANT

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Midpoint
Alencon Link
Basingstoke, RG21 7PP
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LEGEND

- Red Line Boundary

INNS Bird Species

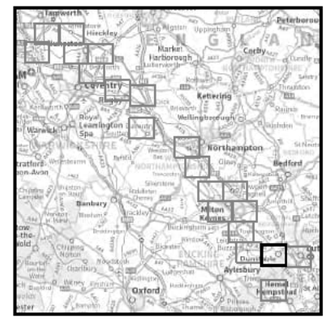
- Black Swan
- Canada Goose
- Egyptian Goose
- Mandarin Duck
- Ring-necked Parakeet

INNS Plant Species

- Wall Cotoneaster

INNS Terrestrial Mammal Species

- Chinese Muntjac
- Eastern Grey Squirrel



NOTES

ISSUE PURPOSE

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FIGURE TITLE

Grand Union Canal
Invasive Non Native Species

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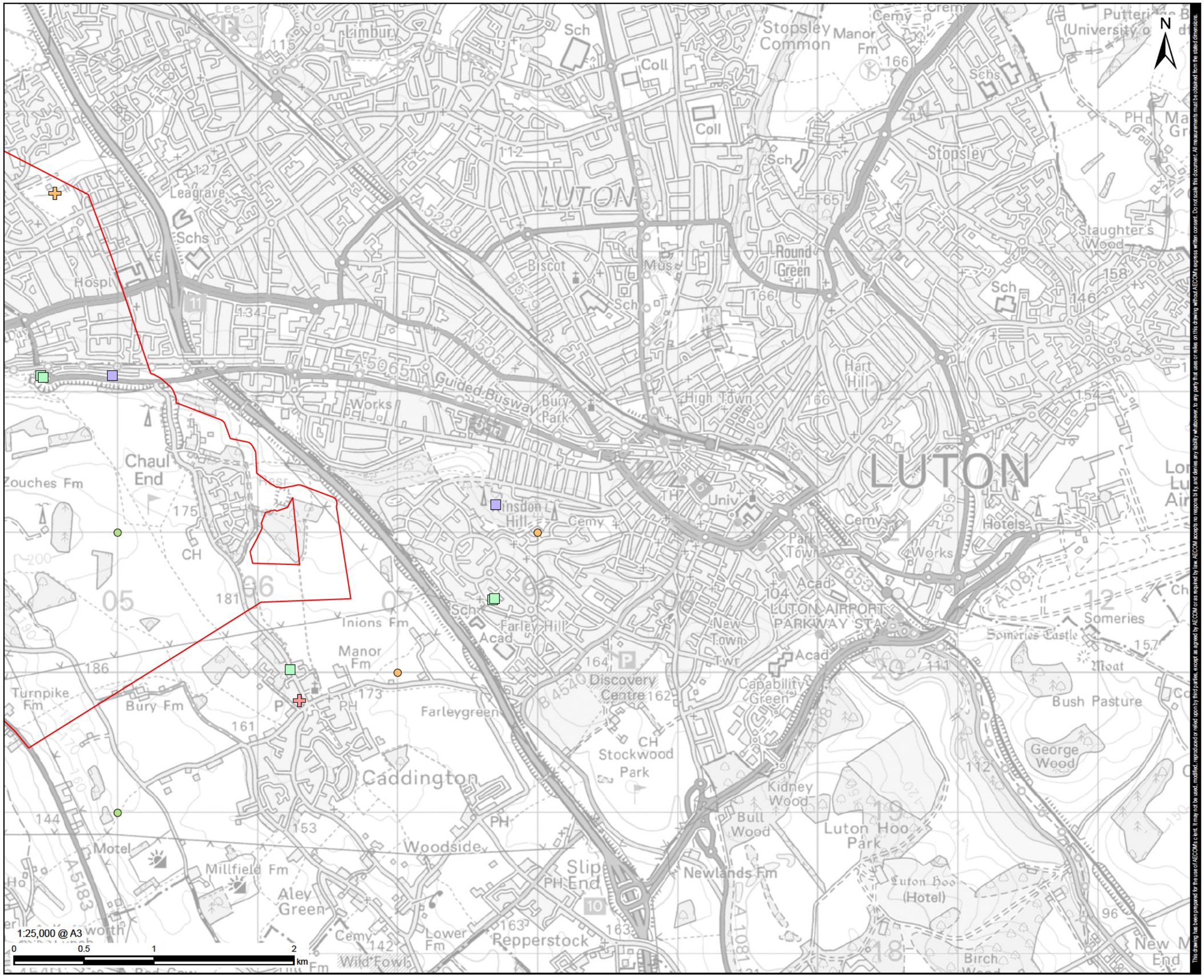

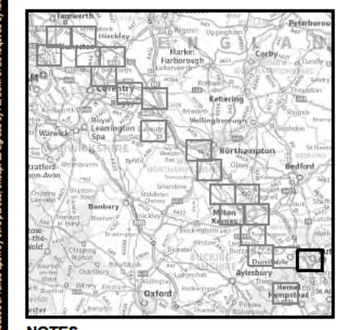

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Canal Transfer Route SRO
Gate 3

CLIENT

Affinity Water

CONSULTANT

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Alencon Link
Basingstoke, RG21 7PP
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LEGEND

- Red Line Boundary

INNS Bird Species

- Canada Goose
- Ring-necked Parakeet

INNS Plant Species

- Himalayan Balsam
- Wall Cotoneaster

INNS Terrestrial Mammal Species

- Chinese Muntjac
- Eastern Grey Squirrel

NOTES

ISSUE PURPOSE

FINAL

PROJECT NUMBER

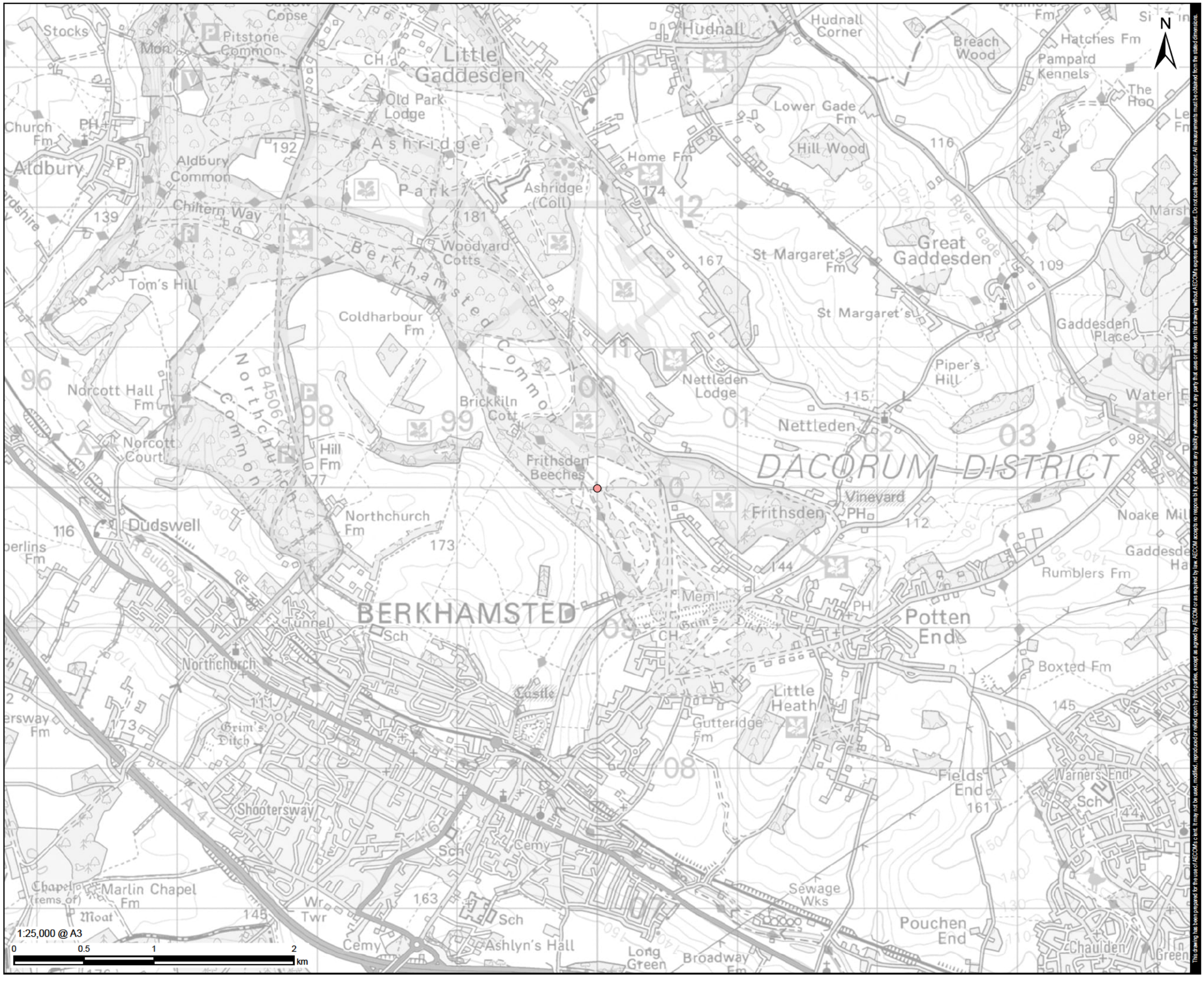
60702564

FIGURE TITLE

Grand Union Canal
Invasive Non Native Species

FIGURE NUMBER

60702565-AW-GUC-000-INNS-1



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Canal Transfer Route SRO
Gate 3

CLIENT

Affinity Water

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Midpoint
Alencon Link
Basingstoke, RG21 7PP
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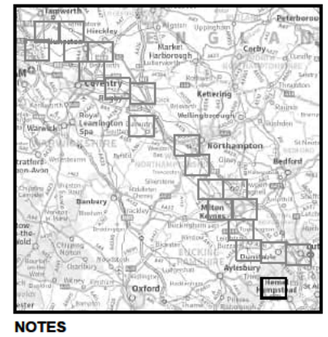
LEGEND

INNS Bird Species

- Canada Goose
- Mandarin Duck



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ISSUE PURPOSE

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PROJECT NUMBER

60702564

FIGURE TITLE

Grand Union Canal
Invasive Non Native Species

FIGURE NUMBER

60702565-AW-GUC-000-INNS-1

Appendix B Legislation

Taken together, INNS relevant legislation (Table B-1) makes it an offence to plant, or otherwise cause to grow (including allowing to spread), listed plant species in the wild and if transported off-site, there is a duty of care with regards to the disposal of any part of the plant that may facilitate establishment in the wild and cause environmental harm (as per the Environmental Protection Act 1990). The legislation also makes in an offense to release, or allow to escape, listed animal species (or animal species not ordinarily resident in and is not a regular visitor to Great Britain in a wild state) into the wild.

While it is not illegal to have listed INNS within a land asset, even when present on managed land (e.g. forming part of landscaping), the spread of listed species should be kept under control such that the species is not having an appreciable adverse impact on habitats and their native biodiversity.

Species of Special Concern should not be kept, bread, transported (unless as part of control action), grown, cultivated, permitted to reproduce, or released into the environment. However, there are exemptions to these requirements where species of special concern have been identified as widespread in England (e.g. Himalayan balsam and signal crayfish). In such cases, steps should be taken to reduce further spread of these species, with localised eradication being carried out in high priority areas where possible, e.g. Sites of Special Scientific Interest (SSSIs), where rare native flora are at threat, and areas at risk of flooding and/or erosion. Management of such species should be based on a cost benefit analysis, which includes an assessment of likely effectiveness and long-term sustainability.

If charged with committing an offence, it is a defence against prosecution to prove that all reasonable steps were taken, and all due diligence exercised in attempting to avoid committing the offence. Therefore, in order to reduce the potential of breaching legislation and fines/prosecution, a management plan should be in place for INNS on a property and property owners should be able to demonstrate that they are following it.

In addition to the listed legislation, the Environment Agency published a position statement on managing the risk of spreading INNS through raw water transfers (EA, 2022). This states that ‘water companies are expected to start work on mitigating the risks of introduction and spread of INNS within existing raw water transfer networks,’ with a focus on the pathway that the raw water transfer creates and precautionary assumptions that maximum impact may occur, rather than current INNS occurrence. This provides a future-proof indication of the inherent risk of the raw water transfer. It is also noted that while ‘assessments should be undertaken at the pathway level; [assessors] are free to address specific species within risk analysis reports, should they consider them to represent a realistic reduction to risk.’

Table B-1 Summary of relevant legislation relating to INNS

Legislation	Summary of Key Aspects
Invasive Alien Species (Enforcement and Permitting) Order 2019 (as amended)	This legislation imposes restrictions on species of animals and plants in Schedule 2 of the Act or listed as ‘Species of Special Concern’. These are species which pose a risk of adverse impacts across the UK and EU, such that targeted action across the UK and EU is required. Restrictions applying to these species mean they cannot not be imported, kept, bred, transported, sold, used or exchanged, allowed to reproduce, grown or cultivated, or released into the environment. Under certain circumstances a Species Control Order can be served on a landowner to require the removal of a given species (see Infrastructure Act 2015). The UK has produced an FAQ document for UK stakeholders outlining the key aspects of the legislation and the obligations of stakeholders in relation to the species on the list of species of special concern. This document states that if the containment of plant species of Special concern cannot be guaranteed, their safe removal should be considered. There are exemptions to these requirements where species of special concern have been identified as widespread in England. However, in such cases, steps must be taken to minimise their impact on native habitats, where management is feasible. Additionally, steps should be taken to reduce further spread of these species, with localised eradication being carried out in high priority areas where poss ble, e.g. Sites of Special Scientific Interest (SSSIs), where rare native flora are at threat, and areas at risk of flooding and/or erosion. Management of such species should be based on a cost benefit analysis, which includes an assessment of likely effectiveness and long-term sustainability.
Wildlife and Countryside Act 1981 (as amended) Schedule 9, Section 14	It is an offence to plant or otherwise cause to grow in the wild any listed plant species. It is an offense to release, or allow to escape, listed animal species (or species not ordinarily resident in and is not a regular visitor to Great Britain in a wild state) into the wild.

	Defra have produced guidance on Section 14 in order to help with the interpretation of the above. Relevant text from the guidance includes: • "We consider that planting in the wild would constitute intentionally placing viable plant material in or on suitable medium so that it can grow." • "we would not consider planting on managed land, where it is expected that the spread of the plant will be kept under control, and where the plant is not having an appreciable adverse impact on habitats and their native biodiversity, as planting in the wild. • "It is our view that for a species to be considered 'ordinarily resident', the population should have been present in the wild for a significant number of generations and should be considered to be viable in the long term." • "We consider 'release into the wild' to be the active letting go of an animal, from a condition of captivity, such that it has the freedom to go where it will. In essence, we consider that the deliberate introduction of an animal into an area considered to be 'the wild' would be an act of release."
Infrastructure Act 2015	Environmental authorities may issue control orders under which landowners can be obligated to carry out species control operations for INNS animal and plant species.
Anti-social Behaviour, Crime and Policing Act 2014 and Community Protection Notices	Local councils and the police have the power to issue Community Protection Notices against "individuals who are acting unreasonably and who persistently or continually act in a way that has a detrimental effect on the quality of life of those in the locality" including for INNS. Breach of any requirement of a Community Protection Notice, without reasonable excuse, would constitute an offence. Guidance released by the Home Office provides information on the reformed Anti-social Behaviour, Crime and Policing Act 2014. The guidance note, primarily aimed at Japanese knotweed, giant hogweed and Himalayan balsam, provides information on how best to proceed if a neighbour is unwilling to control INNS on their property, i.e. they will not treat it with herbicide or remove it. The updated legislation means that if a neighbour 'fails to act' regarding controlling, or preventing the growth of INNS, then a Community Protection Notice can be issued requiring action to be taken. Breach of any requirement of a Community Protection Notice, without reasonable excuse, would be a criminal offence, subject to a fixed penalty notice (which attracts a penalty of £100) or prosecution. On summary conviction, an individual would be liable to a level 4 fine (£2,500). An organisation, such as a company, is liable to a fine not exceeding £20,000.
Environmental Protection Act 1990, Sections 33 and 34	If taken away from the site of origin, listed species and associated material, e.g. soil, may be classified as Controlled Waste and must be disposed following a duty of care. Such waste that is disposed of off-site must be accompanied by appropriate waste transfer documentation and be transported by an appropriately licence waste carrier.
Town and Country Planning Act 1990	Although this Act does not make specific reference to specific weeds, it provides local authorities with power to serve notices on owners or occupiers of land to control weeds that may be harming the amenity of the surrounding area. If the owners and occupiers fail to remedy the situation, they may be liable to a fine or have to repay the costs of action taken by the local authority to control the weeds.
Common Law	There is precedent within Common Law to take civil action against neighbouring landowners where the spread of invasive species is considered to be a private or public nuisance. This is particularly relevant where Japanese knotweed is located on land assets adjacent to residential properties.