Royal Canal, Phibsborough Aquatic Biodiversity Assessment & Management Plan 2022

Prepared by Triturus Environmental Ltd.

for the Shandon Residents Association

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1. Introduction

1.1 Background

Triturus Environmental Ltd. were contracted by the Shandon Residents Association, under funding provided by the Local Authority Waters Programme (LAWPRO), to conduct an aquatic biodiversity audit and management plan for the Royal Canal at Shandon Gardens, Phibsborough, Dublin (**Figure 1.1**). The main objectives of the survey are outlined below with more detailed information provided in the methodology section specific to the objectives;

- Review the targets of the Draft Dublin City Biodiversity Management Plan, County Development Plan and local biodiversity plans to consider relevant biodiversity management targets for the study area.
- Undertake a desktop review of the rare and protected aquatic species including invertebrates, macrophytes (aquatic plants) and fish present within the canal.
- Undertake a desktop review of the water quality of the canal including Water Framework Directive surveillance monitoring reports.
- Establish the existing baseline aquatic ecological attributes of the Royal Canal based on a site survey of the canal upstream of the 6th Lock (**Figure 1.1**).
- This baseline study will document the macrophyte (aquatic plant composition) of the canal in the vicinity of Shandon Gardens inclusive of the emergent herbaceous and reed vegetation in the canal littoral.
- Collect macro-invertebrate samples to establish the presence of regionally rare and or protected invertebrate fauna in the Royal Canal.
- Undertake a fisheries appraisal of the fish species observed including key supporting habitats.
- Review otter data for the study area and establish the status of otter utilisation of the Royal Canal at Phibsborough.
- Provide detailed short and medium-term recommendations to protect, enhance or create new habitat within or contiguous with the existing canal basin, with engagement of the local community.

The findings of the survey will facilitate better understanding, appreciation and, ultimately, management of the Royal Canal within the survey area and its environs as well as more effective engagement between the Shandon Residents Association and stakeholders including the NPWS, Dublin City Council, Waterways Ireland and Inland Fisheries Ireland.

1.2 Relevant biodiversity policies Dublin City Development Plan (2022-2028)

Following a review of the targets of the policies specific to Dublin City, numerous objectives of the Dublin City Development Plan 2022-2028 and the Draft Dublin City Biodiversity Action Plan 2021-2025 were of relevance to the Royal Canal, Phibsborough biodiversity plan. These actions and targets were considered with regards to the management proposals within this report to help promote biodiversity in the Royal Canal. These would be achieved through habitat preservation where features of high local

biodiversity context were identified, through habitat enhancement, habitat creation and through the management of identified threats, including invasive species.

Dublin City Development Plan 2022-2028, relevant objectives and actions:

SI7 Water Quality Status**:** To promote and maintain the achievement of at least good status in all water bodies in the city.

SI8 Physical Condition of Waterbodies: To promote the protection and improvement of the aquatic environment and water-dependent ecosystems through proactive discharge and emissions management and through the enhancement of the physical condition of waterbodies.

Section 15.6.6 Sensitive Ecological Areas: '*In the case of proposals adjacent to a canal, appropriate space should be retained for wildlife and it should also be ensured that wildlife have appropriate access to the water'.*

Draft Dublin City Biodiversity Action Plan 2021-2025, relevant objectives and actions:

Objective 3: Identify and protect sites that have conservation value for biodiversity using evidence-based research.

Objective 4: Monitor and conserve legally protected species within Dublin City, particularly those listed in the annexes of the EU Birds and Habitats Directive using evidence-based research.

Objective 6: Implement measures for species with that have a local biodiversity value or impact local biodiversity.

Objective 7: Prepare and disseminate information on guidance for development and site management for biodiversity conservation.

Objective 8: Devise and implement habitat restoration initiatives across Dublin City.

Objective 9: To use nature-based solutions to restore biodiversity and ecosystem services.

Objective 10: Strengthen measures to control Invasive Alien Species, improve biosecurity and ecological status of catchments.

Objective 13: Pilot initiatives for the creation of habitats using artificial habitat methods.

Objective 16: Increase understanding and appreciation of biodiversity and its importance across Dublin City.

Objective 17: Empower citizens to connect with and take positive action for biodiversity at a local and city-wide level.

1.3 Study area background

The Royal Canal is some 150km long and links the River Liffey in Dublin City with the River Shannon in Co. Longford. The canal is fed by Lough Owel, Co. Westmeath via a feeder channel and flows east to Dublin and west to the Shannon. Though originally constructed for transport of goods (works completed in 1817), the Royal Canal was closed to typical navigation in 1961. The present-day canal serves as a highly valuable recreational amenity site and regionally important ecological corridor. The entire length of the Royal Canal is designated as a proposed Natural Heritage Area (pNHA) (site code: 002103) (NPWS, 1995).

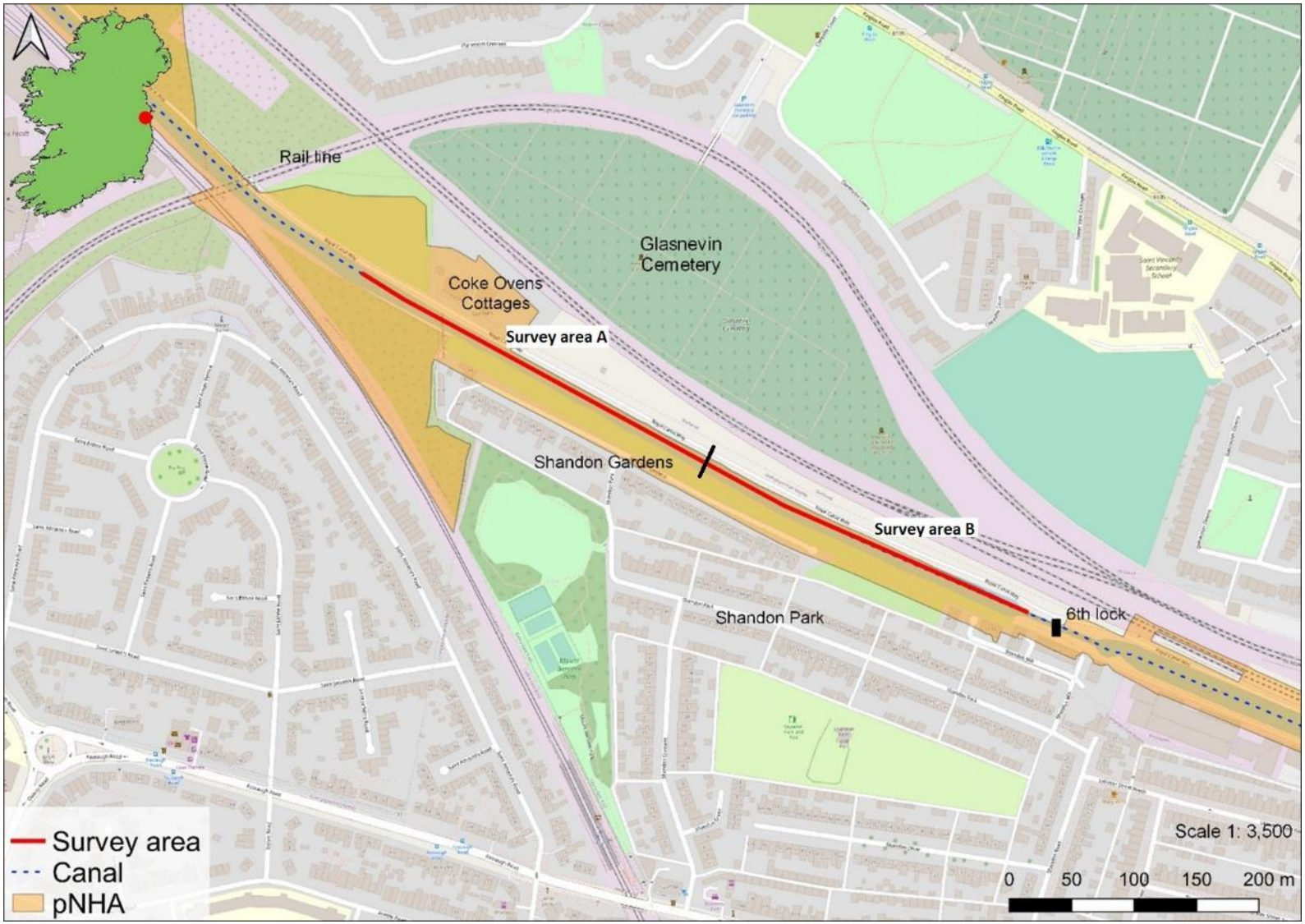

Figure 1.1 Location of the study area on the Royal Canal at Shandon Gardens, Phibsborough, Dublin

2. Methodology

2.1 Desktop review

A desktop survey of published and unpublished data for the Royal Canal in the vicinity of Phibsborough was undertaken in respect of rare and or protected aquatic flora and fauna. Data on protected species and habitats, as well as invasive species listed under the Part 1 of the Third Schedule of the European Communities (Birds and Natural Habitats) Regulations 2011-2021, held by the National Parks & Wildlife Service (NPWS), National Biodiversity Data Centre (NBDC, 1km grid square O1436) and Botanical Society of Britain & Ireland (BSBI) were also reviewed. Water quality data from the Environmental Protection Agency (EPA), Waterways Ireland and Water Framework Directive compliance reports (Caffrey et al. 2021, 20202, 2019) were also examined, as were any previously completed ecological reports available for the survey area (Tubridy, 2021; MacLochlainn, 2004).

2.2 Aquatic macrophyte and bryophyte surveys

In-stream surveys were undertaken with dry-suits to compile macrophyte (aquatic plant) and bryophyte (aquatic mosses and liverworts) records. Samples were collected by hand and or through use of a grapnel in deeper water. The conservation status of recorded species was assessed according to Red Data lists (i.e. Curtis & McGough, 1988; Marnell at al., 2009; King et al., 2011; Lockhart et al., 2012; Wyse-Jackson et al., 2016) and the Flora (Protection) Order, 2022 (S.I. No. 235 of 2022). Species considered by the respective BSBI vice-county recorder to be rare or otherwise notable in the surrounding area were also noted.

2.3 Macro-invertebrate sampling

Two macrophyte sweep sample was undertaken to collate data on the macro-invertebrate community present. The sample was taken with a standard kick sampling hand net (250mm width, 500µm mesh size) which was used to sweep macrophytes to capture macro-invertebrates over a ten meter transect. The net was also moved along the canal bed to collect epibenthic and epiphytic invertebrates from the substratum including the bed and overlying macrophytes (as per Cheal et al., 1993). A 3-minute sampling period was divided amongst the range of canal meso-habitats present to get the best representative sample. Samples were elutriated and fixed in 70% ethanol for subsequent laboratory identification. Any rare invertebrate species were identified from the NPWS Red List publications for beetles (Foster et al., 2009), molluscs (Byrne et al., 2009) and damselflies and dragonflies (Nelson et al., 2011).

The BMWP (Biological Monitoring Working Party) and Average Score Per Taxon (ASPT) biotic indices were used to assess the current biological water quality of the Royal Canal at Phibsborough (June 2022). Whilst not equating to WFD status, these indices provide a qualitative indication of the overall health of the canal. The BMWP score is based on the presence of pollution-tolerant to pollution-sensitive families (Armitage et al., 1983; Hawkes, 1998; Pond Action, 2002). Each family is assigned a score. The BMWP score is the sum of these family scores. Families that are sensitive to pollution are assigned higher scores than pollution-tolerant families. A high overall score indicates that the water quality is good.

The total BMWP score can also be divided by the number of taxa to produce the Average Score Per Taxon (ASPT), yielding a score between 1 and 10. A BMWP score greater than 100 generally indicates very good water quality (Chapman & Jackson, 1996). A high ASPT score i.e. >5.5 is considered indicative of a clean site containing large numbers of high-scoring taxa (pers. obs).

2.4 Fisheries assessment

Given the clear water conditions present in the Royal Canal at Phibsborough it was possible to undertake visual transect surveys for fish. A line transect walkover survey was conducted along the Royal Canal corridor. A total of two transects were undertaken, each measuring 150m in length with a total survey cover of 300m on each bank (**Figure 1.1**). Fish species observed were recorded and their relative abundance was estimated. The use of eDNA metabarcoding or traditional fyke, seine and electro-fishing methodologies was beyond the scope of the current study.

2.5 Otter survey

An otter (*Lutra lutra*) survey was undertaken covering both banks of the canal from the 6th Lock eastwards to the Coke Oven Cottages area with a total survey cover of 600m on each bank of the Royal Canal undertaken (**Figure 1.1**).

The site visits broadly followed the best practice survey methodology for otter as recommended by Lenton et al. (1980), Chanin (2003) and Bailey & Rochford (2006). However, methodology differed in that the entire waterline was surveyed rather than the standard short sections from accessible points (e.g., bridges). The novel survey technique, known as a total corridor otter survey (TCOS) (Macklin et al., 2019), encompassed the entire riparian zone along both banks of the Royal Canal within the survey area.

Where encountered, each otter sign was logged by type, location (handheld GPS), condition and approximate age for later interpretation to distinguish differences in habitat use and activity.

2.6 Invasive species survey

The occurrence, location and density of both aquatic and terrestrial invasive species was noted in respect of the study area, with GPS (ITM) coordinates taken for any records. Primarily the survey focused on common riparian species associated with waterways such as Himalayan balsam (*Impatiens glandulifera*) and Japanese knotweed (*Fallopia japonica*) but other notable invasive plants such as giant rhubarb (*Gunnera tinctoria*) and giant hogweed (*Heracleum mantegazzianum*) were also surveyed for, as were any invasive or potentially invasive aquatic or terrestrial animal species along the Royal Canal corridor.

2.7 Biosecurity

A strict biosecurity protocol following IFI (2010) and the Check-Clean-Dry approach was adhered to during surveys for all equipment and PPE used. Disinfection of all equipment and PPE before and after use with Virkon™ was conducted to prevent the transfer of pathogens or invasive propagules between survey sites and or other waterbodies. Where feasible, equipment was also thoroughly dried (through UV exposure) between survey areas. Any aquatic invasive species or pathogens recorded within or

adjoining the survey areas were geo-referenced with the exception of *Elodea nuttallii* that is very widespread in the Royal Canal. All Triturus staff are certified in 'Good fieldwork practice: slowing the spread of invasive non-native species' by the University of Leeds.

3. Existing environment

3.1 Desktop review

A desktop review of aquatic species of high local biodiversity value, including threatened and or protected flora and fauna records for the study area at Shandon Gardens, was undertaken. The data of relevance was that recorded within the spatial scale of the Royal Canal basin.

3.1.1 Water quality

Unlike natural riverine sites monitored under the Water Framework Directive (2000/60/EC) that have a target of 'good ecological status', canals are considered artificial Water Bodies (AWB's) and must achieve a target of 'good ecological potential' from five assigned categories (i.e. maximum, good, moderate, poor or bad). As canals are entirely artificial, they cannot follow the same status-based system as natural watercourses.

The INVAS Water Framework Directive compliance reports (Caffrey et al. 2021, 2020, 2019) showed relevant ecological water quality data for the section of Royal Canal within the study area by considering macrophytes, macro-invertebrates, invasive species, physiochemistry, microbial pathogens and hydromorphology. The INVAS monitoring points that are closest to the study area are RCE 25 Croke Park and RCE 22 Castleknock (**Figure 2.1**). The results for 2019 and 2020 were 'good' for both monitoring sites. However, during the 2021 monitoring site RCE22 received a moderate score due to a high *E. coli* count of 24,000 per 100 ml, while RCE 25 remained 'good'.

The WFD surveillance monitoring publication 'Water Quality in Ireland 2016-2021' (Trodd et al., 2022) as derived from the INVAS surveys stated that the Royal Canal achieved 'good ecological potential' overall given that most of the sites achieved the maximum ecological potential for the macrophyte, macroinvertebrate and hydromorphological elements. The River Waterbodies Risk score for the Royal Canal was under review at the time of report drafting.

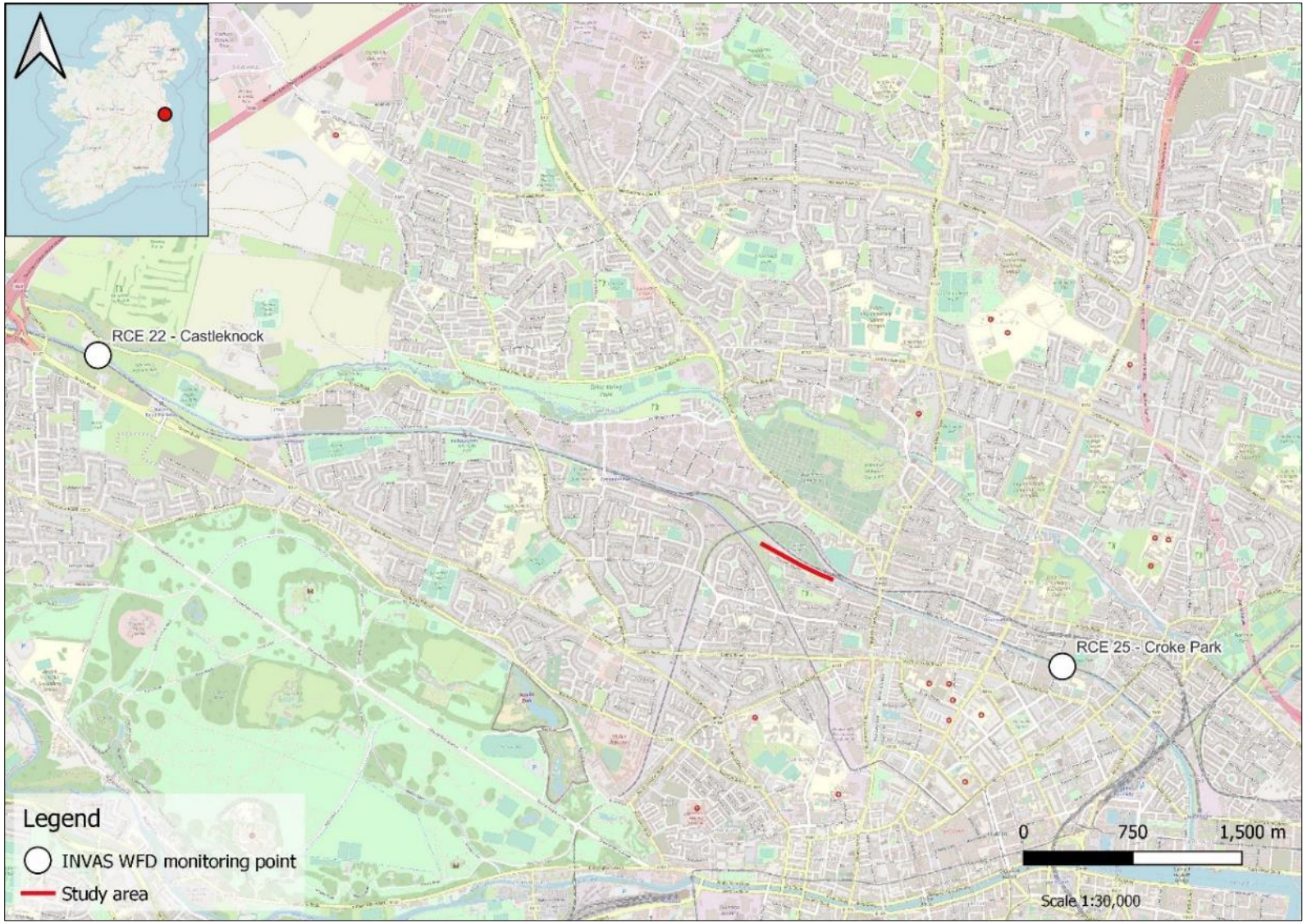

Figure 2.1 Location of INVAS Water Framework Directive monitoring points closest to the study area

3.1.2 Macrophytes (aquatic plants)

The Royal Canal supports a high diversity of macrophyte plants. The most common macrophyte species recorded in the Royal Canal by Caffrey et al. (2021) are summarised in **Table 3.1** below. This includes submerged, floating and emergent species, albeit many are heterophyllous (i.e. can have different forms of leaf on the same plant). *Elodea* species that include *Elodea canadensis* and *Elodea nuttallii*, are both listed as invasive plant species on the 3rd schedule of the European Communities (Birds & Natural Habitats) Regulations 2011-2021. The rare species opposite-leaved pondweed (*Groenlandia densa*) has been recorded in several sections of the Royal Canal (1st to 4th levels, inclusive) (BEC, 2011) but is not known west of the 6th Lock. The species is legally protected under schedule A of the Flora (Protection) Order 2022 (S.I. No. 235 of 2022).

Tassel stonewort (*Tolypella intricata*), listed a vulnerable, red-listed stonewort in Ireland (Stewart & Church, 1992), is also known from the Royal Canal in Dublin. The species has been recorded historically from the Royal Canal between Cross Gun's Bridge (5th lock) and Granard Bridge (near 12th lock), with records from 1992 (Nash & King, 1993). The species was recorded typically within 1m metre from the bank growing in silt in 0.5m water depth (Nash & King, 1993). *Tolypella intricata* has only been recorded in Ireland twice since 1993 with records only for the Grand Canal (Paul Green, BSBI, pers. comm.).

Table 3.1 Most common aquatic macrophytes and bryophytes in the Royal Canal (Caffrey et al., 2021)

Common name	Scientific name	Submerged (S), Floating (F), Emergent (E) [1]
Canadian waterweed	*Elodea canadensis**	S
Nuttall's pondweed	*Elodea nuttallii**	S
Common water moss	*Fontinalis antipyretica*	S
Stonewort	*Chara* sp.	S
Broad-leaved pondweed	*Potamogeton natans*	F
Bristly stonewort	*Chara hispida*	S
Yellow water lily	*Nuphar lutea*	F
Unbranched bur-reed	*Sparganium emersum*	S, E
Whorl-leaf milfoil	*Myriophyllum verticillatum*	S
Bulrush	*Typha latifolia*	E
Arrowhead	*Sagittaria sagittifolia*	E, S, F
Greater spearwort	*Ranunculus lingua*	E
Common clubrush	*Schoenoplectus lacustris*	E
Lesser-pond sedge	*Carex acutiformis*	E
Yellow flag	*Iris pseudacorus*	E
Reed sweet-grass	*Glyceria maxima*	E

[1] Many macrophytes are heterophyllous and can possess floating, emergent and or submerged leaves on the same plant.
*Invasive plant listed on the 3rd schedule of the European Communities (Birds & Natural Habitats) Regulations 2011-2021.

3.1.3 Fisheries

As the Royal Canal was built for navigation and features numerous locks (instream barriers), migratory fish species like Atlantic salmon (*Salmo salar*), sea lamprey (*Petromyzon marinus*) and river lamprey (*Lampetra fluviatilis*) are not known to occur in the canal. However, brook lamprey (*Lampetra planeri*) occur very locally in the Royal Canal where feeder channels enter the waterbody. The Royal Canal also supports small numbers of European eel (*Anguilla anguilla*) that use the canal as a nursery area, including some very large specimens to 2kg (pers. obs.). However, the Royal Canal is considered primarily as a coarse fish habitat. Such species include pike (*Esox lucius*), perch (*Perca fluviatilis*), roach (*Rutilus rutilus*), rudd (*Scardinius erythropthalmus*), bream (*Abramis brama*), roach x bream hybrids, three-spined stickleback (*Gasterosteus aculeatus*) and tench (*Tinca tinca*) (McCloone, 2011; Tierney et al., 1999).

Plate 3.1 Multiple cohorts (year classes) of roach captured from a kick net at Phibsborough, June 2022

3.1.4 Otter

There were no records available for otter within the 1km grid square O1436 containing the survey area. However, otter do occasionally forage in the vicinity of Phibsborough given the presence of large shoals of roach and perch (Terry Doherty, pers. comm.). Otter frequently spraint in the Royal Canal in the vicinity of Croke Park downstream of the study area while they are also seen very frequently west of the study area in the vicinity of Broomsbridge. This area is considered one of the strongholds for otter on the Royal Canal.

Plate 3.2 Otter can forage easily in vegetated channels as they use vegetation to trap prey (Photo credit, Pascal Sweeney)

3.1.5 Invertebrates

Several rare or declining aquatic molluscs have been recorded from the Royal Canal (Byrne et al., 2009; Moorkens & Killeen, 2005) including the whirlpool ramshorn snail (*Anisus vortex*), a species that has its stronghold in the River Shannon. The ICUN endangered molluscan species the false orb pea mussel (*Pisidium pseudosphaerium*) and glutinous snail (*Myxas glutinosa*) are also known from the Royal and Grand Canals. No previous records for the study area for either species were known of at the time of this review.

3.1.6 Waterfowl

An assessment of waterfowl (waterbird) usage of the Royal Canal was not part of the scope of the current study. However, given the importance of littoral emergent reed and herbaceous vegetation as waterbird nesting areas, a review of their usage of the study area was undertaken. A summary of the bird species recorded in the study area upstream of Lock 6 as previously recorded in the Shandon Area Ecological Report (Tubridy, 2021; MacLochlainn, 2004) are summarised in **Table 3.2**.

Table 3.2 Previously recorded aquatic bird species (after Tubridy, 2021 & MacLochlainn, 2004)

Common name	Scientific name	Residential status	Breeding status
Grey heron	*Ardeer cinerea*	Resident	Breeding nearby assumed
Cormorant	*Phalacrocorax carbo*	Casual visitor	n/a
Mute swan	*Cygnus olor*	Resident	Breeding
Mallard	*Anas platyrhynchos*	Resident	Breeding
Tufted duck	*Aythya fuligula*	Resident	Breeding assumed; stock of feral origin
Moorhen	*Gallinula chloropus*	Resident	Breeding
Kingfisher	*Alcedo atthis*	Casual visitor	Breeding assumed west of lock 7

3.2 Survey results

3.2.1 Site descriptions

The study area was divided into two discrete survey blocks upstream of Lock 6. These included survey area A between the Coke Oven Cottages to the midway point of the survey area, c.300m west of Lock 6. Survey area B continued from this point to Lock 6 (see **Figure 1.1**). The site descriptions based on the survey carried out on the 16th June 2022 include an overview of the character of the study area with more detailed information on macrophyte plants, riparian habitats, invertebrates and fish provided in the subsequent sections

Survey area A (0-300m)

The Royal Canal in survey area A between the Coke Oven Cottages and the midway point to Lock No. 6 was situated in a 10 to 12m wide section of the canal with central depths ranging between 1m to 1.5m deep (shallower than area B). The canal had more gently sloping margins than area B with a flat central base. The canal supported abundant whorled water-milfoil (*Myriophyllum verticillatum*), a dominant submerged species with occasional invasive Nuttall's pondweed (*Elodea nuttallii*) and rare Canadian pondweed (*Elodea canadensis*). The sloping margins of the canal supported abundant bristly stonewort (*Chara hispida*) with occasional small pondweed (*Potamogeton berchtoldii*). The margins supported higher densities of emergent herbaceous and floating macrophyte species than survey area B downstream. These included emergent branched bur-reed (*Sparganium erectum*) that was occasional alongside water plantain (*Alisma plantago-aquatica*). Floating yellow water lily (*Nuphar lutea*) was locally frequent but mostly along the south bank of the canal. A single stand of white water-lily (*Nuphar alba*), recorded as rare, was present opposite the Coke Oven Cottages (**Plate 3.1**). Fish species observed in this area included shoals of roach and perch and a single observation of juvenile pike. No signs of otter were recorded during the site visit.

The canal verges supported abundant false oat grass (*Archenteron elatius*) with cock's foot (*Dactylis glomerata*) and reed canary grass (*Phalaris arundinaceae*) recorded as occasional. Meadowsweet (*Filipendula ulmaria*) was locally frequent with meadow buttercup (*Ranunculus acris*). Yellow flag (*Iris pseudacorus*) was also locally frequent alongside common hogweed (*Heracleum sphondylium*).

Plate 3.3 White water-lily was recorded opposite the Coke Ovens Cottages

Survey area B (300m-600m)

The Royal Canal in survey area B was situated from the midway point of the survey area to Lock 6, spanning 300m. The survey area was located in a 10 to 12m wide section of the canal with central depths deeper than survey area A ranging between 2m and 2.5m. The canal had steep sloping margins with a flat central base being broadly trapezoidal in shape. The dominant submerged macrophyte species was whorled water-milfoil (**Plate 3.2**). Invasive Nuttall's pondweed was occasional with Canadian pondweed recorded as rare. The canal also supported small pondweed (*Potamogeton berchtoldii*) that was also recorded as rare. As with survey area A, the sloping margins of the canal supported locally frequent bristly stonewort with clustered stonewort (*Tolypella glomerata*). Clustered stonewort is a nationally uncommon species but is not a red listed species or listed on the Flora Protection Order. The species has been recorded historically in the Royal Canal between Phibsborough and Blanchardstown (BSBI data). This species was situated in more open water of the canal margin immediately upstream of Lock 6 on the north bank and the find is notable given the species in uncommon. The emergent and floating leaved macrophyte species included localised water plantain, mares'-tail (*Hippuris vulgaris*), amphibious bistort (*Persicaria amphibia*) and yellow water lily. The canal walls near the lock gates supported abundant aquatic moss *Fontinalis antipyretica* with floating and submerged ivy-leaved duckweed (*Lemna trisulca*) occasional in large clumps in the margins. Shoals of roach and perch were observed throughout.

The canal verges supported mixed reed and grass communities with flowering plants. These included reed canary grass, common hogweed, yellow flag meadow buttercup (*Ranunculus acris*), false oat grass and hedge bindweed (*Calystegia sepium*). The north bank supported a similar community but with more abundant great willowherb (*Epilobium hirsutum*), red valerian (*Centranthus ruber*) and bird's-foot trefoil (*Lotus corniculatus*).

Plate 3.4 Whorled water-milfoil (*Myriophyllum verticillatum*) was the most abundant macrophyte species recorded in the Royal Canal near Shandon Gardens at Phibsborough

3.2.2 Macro-invertebrates

Two macro-invertebrate sweep samples were collected from survey areas A and B of the canal (**Figure 1.1**). A good diversity of macro-invertebrate taxa was recorded with *n*=16 species recorded from survey area A and *n*=19 species from survey area B. The BMWP scores and ASPT scores were considered moderate to good (**Table 3.3**). The presence of five caddis species in survey area B increased the biological monitoring working party (BMWP) score at that site and also the average score per taxon (ASPT).

Two specimens of the ICUN endangered snail *Myxas glutinosa* (Byrne et al., 2009) were recorded from the Royal Canal at Phibsborough. Further validation with live specimens was recommended by Dr. Evelyn Moorkens (pers. comm.), which was welcomed given the known large variation (phenotypic plasticity) in *Ampullaceana balthica* that can look similar when examining dead specimens. However, based on field observations at the time and known presence of the species within the wider Royal Canal, and the low number of specimens recorded, it is unlikely that the records are of *Ampullaceana balthica.* The species has a mantle extending over the thin shell and the extending animal often looks coruscate when it catches the light.

The survey area also supported the cased caddis species *Leptocerus tineiformis*, a species that has a more localised distribution nationally (O' Connor, 2020; NBDC data). The record is thus considered notable. The other caddis species recorded, namely *Agrypnia obseleta*, *Plectronemia conspersa* and *Triaenodes bicolor* are more widespread species in Ireland but nonetheless contribute to the diversity of the study area. A single damselfly species, the variable damselfly (*Coenagrion pulchellum*), was recorded at the two survey locations on the Royal Canal. This species is one of the most common damselfly species in Ireland.

Table 3.3 Macro-invertebrate species composition of the Royal Canal at Phibsborough

Common name	Scientific name	Survey area A	Survey area B	BMWP[2]
Gammaridae	*Gammarus duebeni*	2	1	**6**
Hydrachnidiae	species indet.		1	**n/a**
Chironomidae	non-*Chironomus* spp.	46	13	**2**
Chironomidae	*Chironomus* spp.	1	1	**2**
Ceratopogonidae	*Ceratopogonid* sp.	2	6	**n/a**
Culicidae	species indet.		1	**n/a**
Corixidae	Corixid nymph	6	1	**5**
Asellidae	*Asellus aquaticus*	101	103	**3**
Sphaeriidae	species indet.	4	6	**3**
Planorbidae	*Planorbis planorbis*	1	1	**3**
Bithyniidae	*Bithynia tentaculata*	54	22	**3**
Physidae	*Physa fontinalis*	5		**3**
Lymnaeidae	*Myxas glutinosa*	1	1	**3**
Neritidae	*Theodoxus fluviatilis*		1	**6**
Phryganeidae	*Agrypnia obseleta*	1	2	**10**
Polycentropodidae	*Plectronemia conspersa*		1	**7**
Leptoceridae	*Leptocerus tineiformis*	3	8	**10**
Leptoceridae	*Triaenodes bicolor*		1	**10**
Leptoceridae	*Athripsodes aterrimus*		4	**10**
Coenagrionidae	*Coenagrion pulchellum*	2	1	**6**
Glossiphoniidae	sp. indet.	1		**3**
Tricladida	sp. indet.	2		**5**
Species Richness *n*		**16**	**19**	
Total abundance		**232**	**175**	
BMWP score		**64**	**92**	
ASPT score		**4.6**	**5.4**	

[2] Higher scoring invertebrate taxa are indicative of improved biological water quality conditions with scores ranging between 1 and 10.

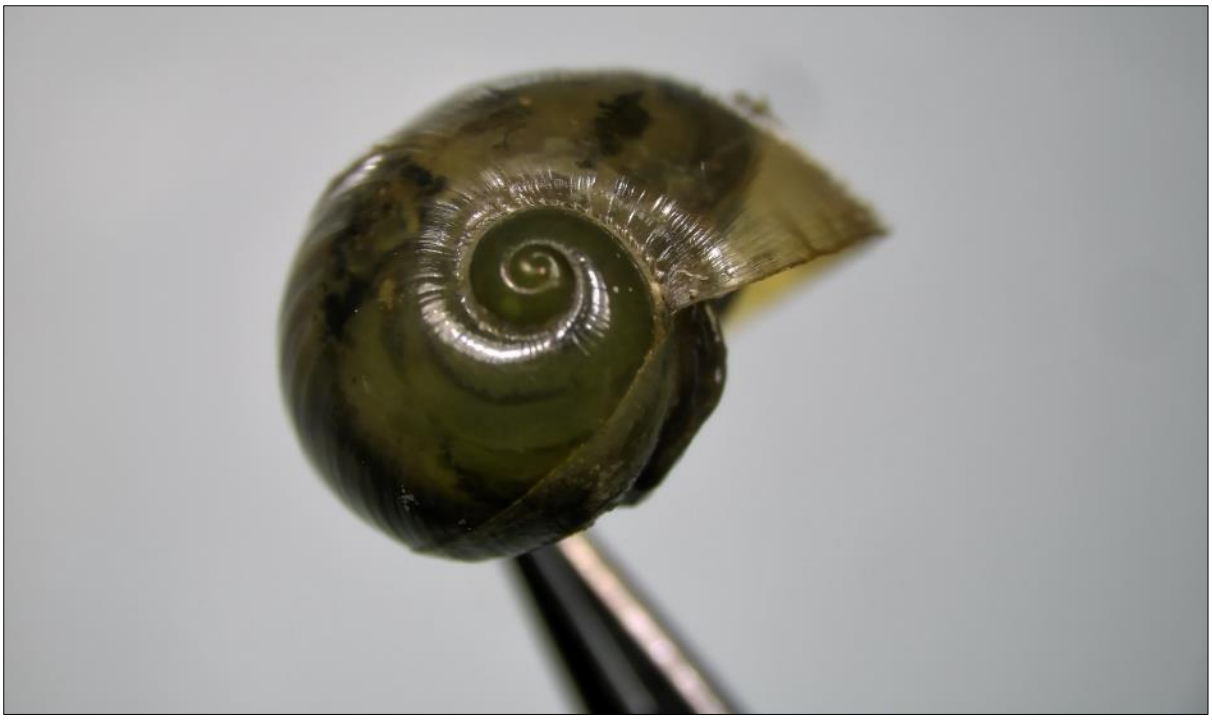

Plate 3.5 The endangered aquatic snail *Myxas glutinosa* recorded at the Royal Canal, Phibsborough in June 2022

Plate 3.6 Live specimen of *Myxas glutinosa* (photo credit: Dr. Roy Anderson)

4. Management for biodiversity

The formulation of short-term (less than a year), medium-term (1-3 years) and long-term (3-5+ years) management goals as part of this biodiversity plan are important in preserving and enhancing the environment of the Royal Canal at Shandon Gardens. Of note is the known occurrence of high conservation value species such as clustered stonewort (*Tolypella glomerata*), glutinous snail (*Myxas glutinosa*), the cased caddis species (*Leptocerus tineiformis*) and otter (*Lutra lutra*) within the survey area.

Proposed management measures include canal bank (riparian) management, habitat creation and water quality monitoring, all of which are synonymous with the management objectives of the Dublin City Development Plan 2022-2028 (see introduction **Section 1.2** for a summary of these targets). The recommended locations for the proposed management measures are presented in **Figure 4.1** below. Please note all habitat measures will need to be agreed in conjunction with the relevant stakeholders as appropriate including Dublin City Council, Waterways Ireland, Inland Fisheries Ireland and the National Parks and Wildlife Service under the stewardship of LAWPRO.

4.1 Short-term management options (2023)

A number of options for short-term biodiversity management goals have been proposed for 2023 and beyond. They include initiatives such as biodiversity signage and a canal bank aquatic biodiversity talk.

4.1.1 Aquatic biodiversity signage

It is recommended to install signage (lecterns) featuring rare aquatic invertebrates and macrophytes to highlight the less studied groups of flora and fauna. Macro-invertebrates form the base of all aquatic food webs and include species which are sensitive to declines in water quality. Increasing awareness of such species would work together with citizen-based water quality monitoring efforts as outlined below, and further educate the local community as to their importance. Signs could highlight the canal-dwelling species. The signage should be designed and drafted in consultation with an experienced aquatic ecologist to ensure accuracy.

4.1.2 Canal bank biodiversity talk

An aquatic ecologist should be commissioned to undertake a canal side ‘walk and talk’ event for the local community. This could also involve local schools. The ecologist could collect macro-invertebrate and aquatic plant samples from the canal to show participants. They could illustrate the threats to the canal and explain why the management measures are essential to improve its biodiversity value.

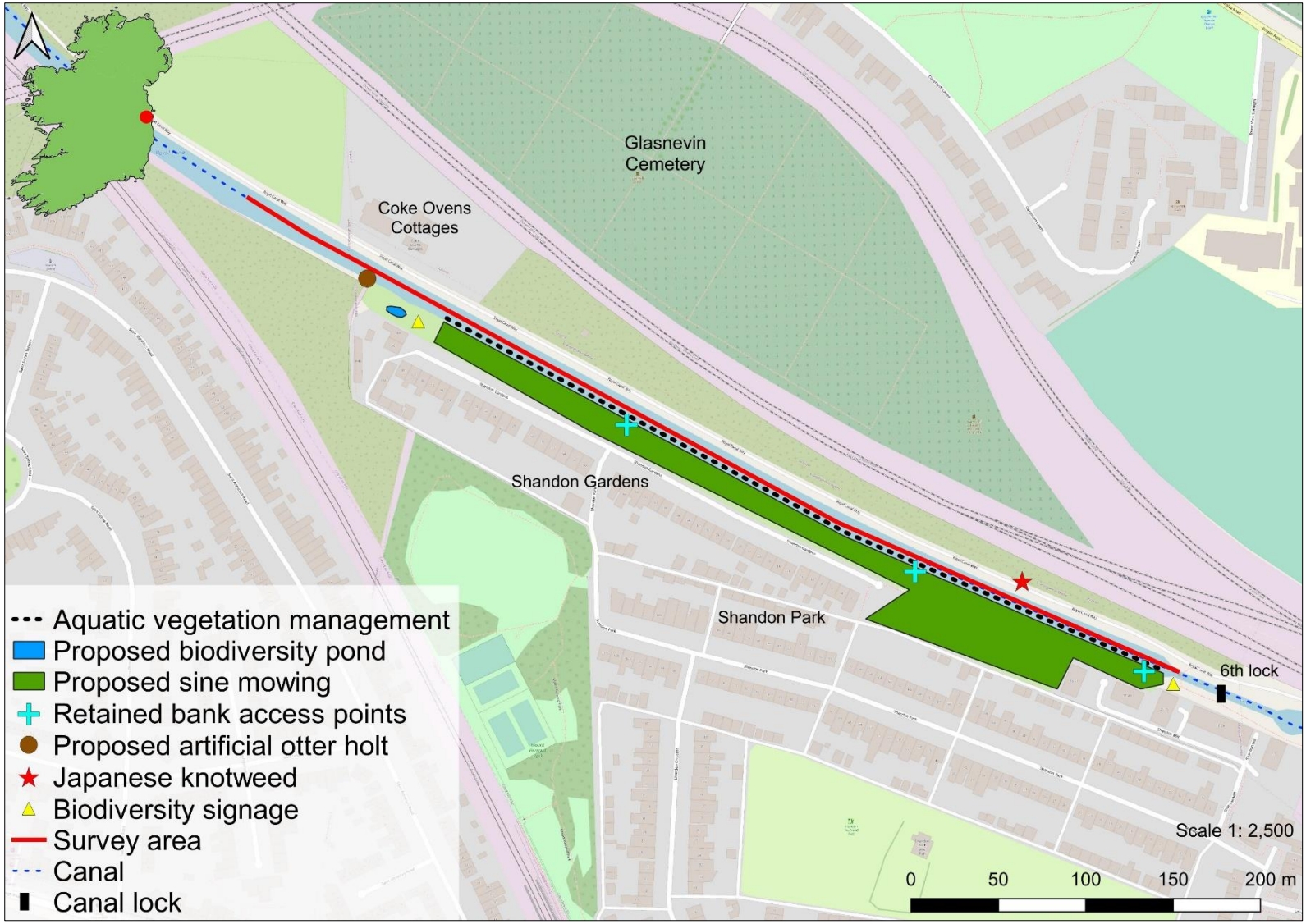

Figure 4.1 Proposed biodiversity enhancement measures at Shandon Gardens

4.2 Medium-term management options (2023-2025)

Several options for medium-term biodiversity management goals have been proposed for 2023-2025. Measures include the designation of waterside access points to reduce bank and littoral vegetation erosion, aquatic vegetation cutting and the management of non-native, invasive plants.

4.2.1 Designated waterside access

The Shandon Gardens (southern) bank of the Royal Canal supports meadow vegetation adjoining the canal and herbaceous vegetation along the canal littorals. As the canal bank at Shandon Gardens is a popular amenity area, damage to the riparian grassy verges, reed swamp and herb vegetation was evident with both soil erosion and trampling visible. Continual erosion of the banks is causing the canal littorals and riparian areas along the canal banks to deteriorate with associated disturbance to waterfowl breeding areas. A total of 26 no. access points by people and dogs were recorded along the canal margins on the south bank. At these locations vegetation had been trampled with associated soil erosion to varying degrees of severity from low to very high (**Table 4.1**).

To create refugia for biodiversity to maintain a healthy canal littoral and riparian zone it is recommended to decrease the number of these access points to a maximum of three (see **Figure 4.1**). At these three retained access locations the erosion could be managed to prevent further deterioration by creating short boardwalk structures made from recycled plastic (i.e. most durable material option). The remainder of the bank could be restricted to human and dog access by creating a low-level double post and low rail fence. Information signs should be put in place to inform residents and visitors of the reasons this management strategy is being applied. This management measure is considered very important to reduce the level of erosion and random access points that are damaging littoral and riparian vegetation of the canal.

Table 4.1 Bank erosion data points collated for the south bank of the Royal Canal

Access point	Relative level of bank erosion	Width of bank eroded (m)	ITM X	ITM Y
1	High	1.5	714686	736430
2	Low	1.0	714681	736431
3	Low	0.5	714661	736440
4	Low	0.5	714656	736441
5	Low	0.5	714649	736445
6	Low	1.0	714629	736458
7	Low	1.5	714599	736468
8	Moderate	0.5	714583	736474
9	High	5.0	714550	736488
10	Moderate	4.0	714517	736502
11	Moderate	1.5	714511	736510
12	Low	2.0	714503	736511
13	Moderate	1.5	714496	736514
14	High	2.5	714486	736518
15	Moderate	2.0	714464	736532
16	Moderate	22.0	714452	736537
17	Moderate	1.0	714429	736549
18	Moderate	1.0	714416	736555
19	High	5.0	714400	736566
20	High	5.0	714385	736572
21	High	4.0	714377	736578
22	Very high	6.0	714314	736611
23	Moderate	6.0	714295	736625
24	Moderate	2.0	714281	736631
25	Very high	6.0	714240	736652
26	Very high	12.0	714267	736636

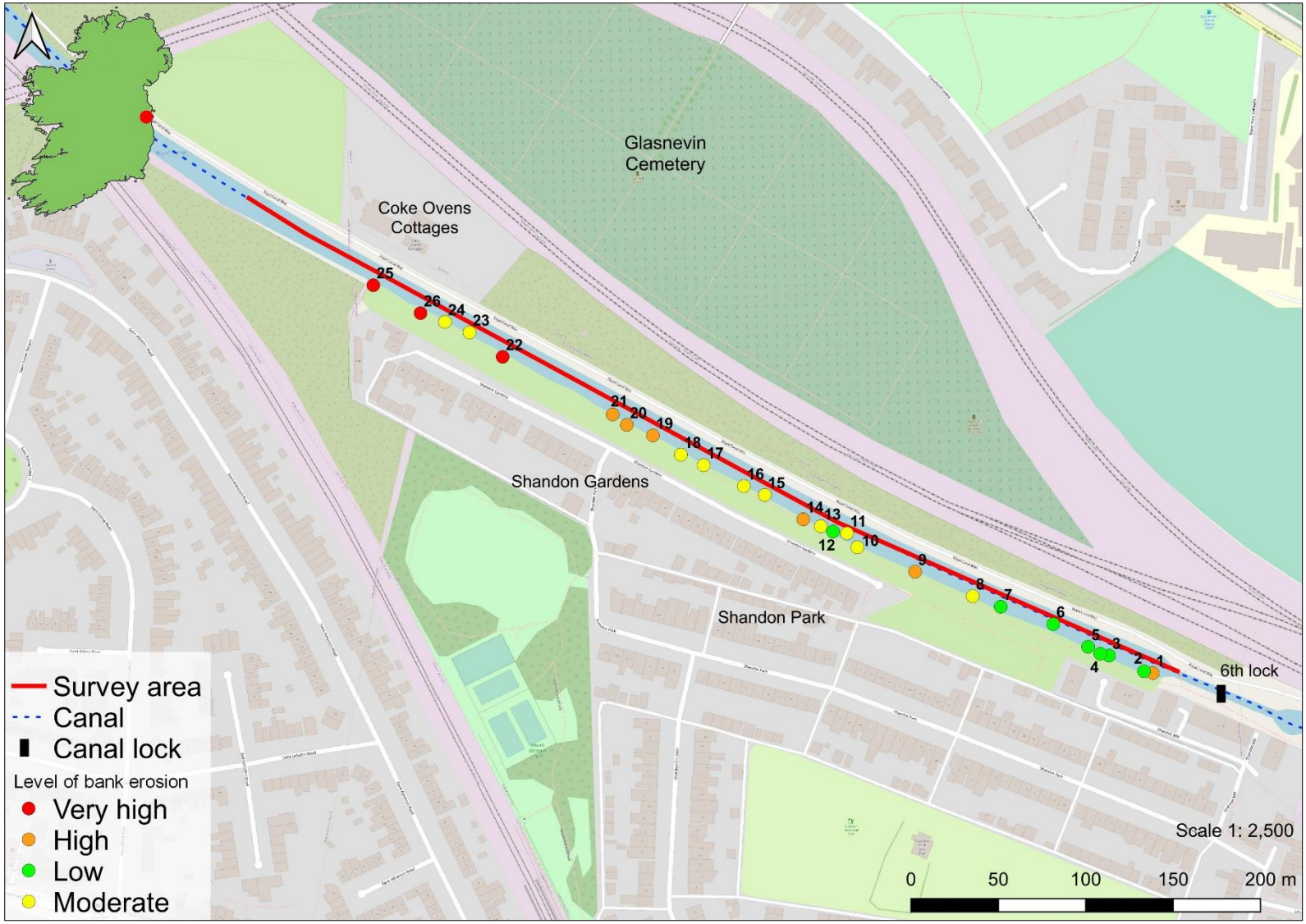

Figure 4.2 Current bankside access points where bank erosion and or trampling of vegetation has been recorded upstream of the 6th Lock

4.2.2 Aquatic vegetation cutting

Aquatic vegetation cutting is carried out routinely (by Waterways Ireland) to facilitate continued navigation of the canal. Whorled water-milfoil (*Myriophyllum verticillatum*) is invasive of the canal basin, outcompeting other native macrophyte plants when growth is unchecked. Cutting water-milfoil with a weed cutting boat is considered beneficial for biodiversity but it should also consider the ecological calendar inclusive of the coarse fish breeding season (1st April to 1st July) and the bird breeding season (1st March to 31st August). Where cutting is unavoidable due to the rapid growth of *Myriophyllum* a 1m buffer from the emergent herbaceous vegetation of the littoral should be maintained as a no-cut zone. This would encourage the development of the macrophyte vegetation in the littoral. A 'sine-graph' vegetation cutting approach could also be applied outside of the 1m buffer where hypothetical sections 1, 3 and 5 are maintained in early spring and 2, 4 and 6 are maintained in autumn. This method of maintenance ensures there is always habitat present for local wildlife but ensures plant growth does not become invasive.

Another suggested method of removing *Myriophyllum verticillatum* is to remove their 'turions' (the over-wintering state of the plant). Harvesting these turions during winter, as recorded at a trial site in the Royal Canal in 1995, dramatically reduced subsequent growing seasons (Caffrey & Monaghan, 2006). *Myriophyllum* produces turions from September to November which means the best time to remove these is during November. This may help reduce the requirement for late spring and summer cutting during the peak of the bird nesting and coarse fish breeding season. While it may not be feasible to adopt these management protocols over the whole canal, their application in the study area covering c. 300m, in consultation with Waterways Ireland, should be considered.

4.2.3 Non-native invasive species management

The study area contained a single, semi-mature stand of Japanese knotweed (*Reynoutria japonica*) that was <3m^2 in area and situated behind the tow-path wall on the north bank (ITM 714611, 736482) (**Figure 4.1** and **Plate 4.2**). Given the proximity of the stand to the Royal Canal and because of its small surface area, it is recommended that it is treated by stem injection with a DAFM approved herbicide such as glyphosate. Stem injection would prevent non-target drift of herbicide and thus treat the knotweed without impacting adjoining wildflowers and pollinating insects.

Plate 4.1 Stand of immature Japanese knotweed situated behind the retaining wall of the north bank of the canal

4.2.4 Artificial otter holt installation

Otters, along with their breeding and resting places, are protected under provisions of the Irish Wildlife Acts 1976-2021. Otters have additional protection because of their inclusion in Annex II and Annex IV of the Habitats Directive 92/43/EEC, which is transposed into Irish law by the European Union (Birds and Natural Habitats) Regulations 2011-2021.

Therefore, otter habitat creation should also be considered as part of the wider aim of enhancing biodiversity. Otters are known to use the Royal Canal for commuting and occasional foraging in the vicinity of Shandon Gardens but the area supports no breeding and or resting areas (pers. obs.).

It is considered that the installation of an artificial otter holt in the bramble scrub east of the palisade fence, opposite the Coke Oven Cottages adjoining the disused CIE lot would be beneficial to otter. These lower-disturbance areas (i.e. poorer human access) offer inherently higher seclusion for otter and would, therefore, be suitable sites for artificial holt installation. Holts can be constructed from proprietary 'flat-pack' recycled plastic kits (**Plate 4.3**) or using locally available materials such as timber or tree logs. In more recent times the efficacy of log holts and timber holts is considered optimal over proprietary flat pack designs (pers. obs.). It should be noted that whilst some otter holt suitability exists along the south bank of the canal at the disused CIE lot, future proposals for development would considerably reduce construction viability meaning further research and consultation with stakeholders and planners would be required.

Plate 4.2 Example of a recycled-plastic artificial otter holt constructed on-site and installed by Triturus in 2020

Plate 4.3 Potential area for the installation of an artificial otter holt on the right-hand side of picture to right of palisade fence and old wall in an inaccessible area of low disturbance

4.2.5 Grassland management (Sine Mowing)

It is recommended that the meadows that have been created at Shandon Gardens on the south bank of the canal consider a novel approach to cutting known as 'sine mowing'. The method has been successful in The Netherlands and Belgium and is eponymous with 'sine waves' due to the pattern of cultivation. The principal is that selected areas are mowed during an even year and are alternated with other areas that are mowed in the subsequent year (i.e. odd year). This pattern of mowing creates sward height diversity, provides a range of grasses more time to establish, and ultimately improves floral and insect diversity that also benefits predators such as mammals, birds and bats. Sine mowing also increases the resilience of a grassland habitat by creating variable microclimates and ensures butterflies, bees, hoverflies, grasshoppers and plant species have better chances of establishing. It is important to remove cuttings and diversify the number of mow cycles per year (Stip et al., 2020; Uytvanck et al., 2017). By documenting the species diversity in the meadow and by recording and photographing the approach taken, evidence-based management of the meadow can be applied. This includes the application of additional cuts and or contribution of additional species sourced locally from existing meadows in the vicinity of the Royal Canal at Phibsborough. Advice from a botanical expert should be sought when adding and or importing plant material as species not of local provenance can compete with local plant communities and inadvertently extirpate plant-pollinator associations.

A schematic is shown in **Figure 4.4** that illustrates sine mowing in an area of grassland. On a berm sine mowing can take the more literal form of an actual sine wave (**Plate 4.5**). A sign should be erected following cutting to inform members of the public of the reasons this management strategy is being applied.

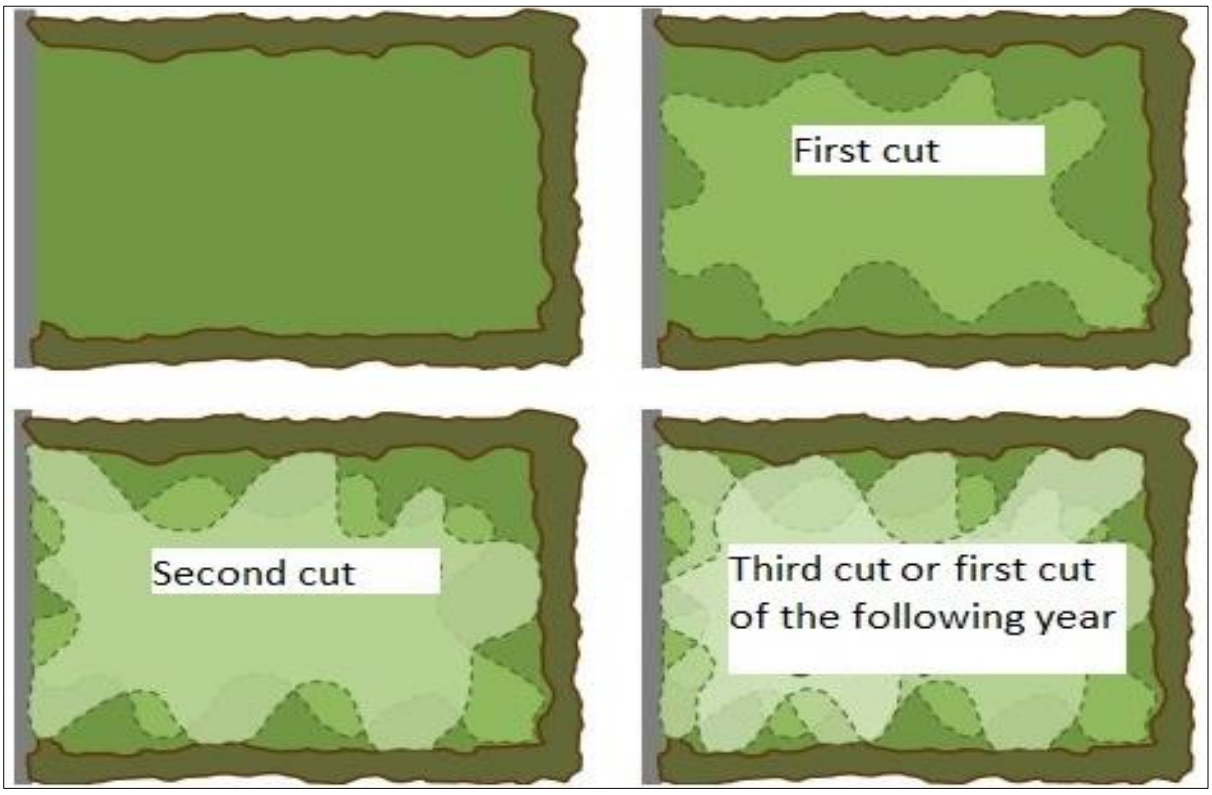

Figure 4.4 Sine mowing schematic of an area of grassland (translated from Uytvanck, 2017)

Plate 4.5 Principal of sine mowing a berm illustrating different height swards (Stip et al., 2020)

4.2.6 Green Infrastructure mapping

Green Infrastructure is the network of habitats where important ecosystem services are provided. In the case of the Phibsborough study area this includes the Royal Canal and the adjoining semi-natural grassland, scrub, treelines and mixed broadleaved woodland habitats that adjoin the canal corridor. Ecological corridors facilitate the movement of plants and animals between semi-natural habitats and are vital in cities where such connectivity is often severed by development pressures. The ecological features providing green infrastructure should be first identified by functional green infrastructure mapping where not only the link is identified but the ecological services the habitat offers to the supporting species. A key example would be otter movement unrestricted along the canal corridor, inclusive of supporting breeding and resting habitat. Similarly, badgers require grassland and woodland foraging areas that can be cut off if population movements are poorly understood. Sections of the Royal Canal located within built-up areas require additional habitat creation or enhancement, such as planting adjoining hedgerows or treelines that provide food for birds and mammals to improve ecosystem service provisioning. Green infrastructure along the Royal Canal should be mapped with a management plan for the preservation of contiguous habitat blocks and their supporting habitats and species.

4.3 Longer-term management options (2026+)

4.3.1 Biodiversity pond creation (with amphibian hibernacula)

Ponds are an important biodiversity resource in the Irish landscape, supporting a wide variety of plants and animals that live in or near freshwater habitats. They provide connectivity, acting as important stepping stones and refugia for native species (Gioria et al., 2010), including common frog and smooth newt. The creation of an open-water pond basin with wetland fringe would greatly improve the biodiversity gains in the Shandon Gardens area, as well as provide an additional biodiversity educational resource.

We propose to create a small dragonfly and amphibian pond in an existing area of amenity grassland within Shandon Gardens (**Figure 4.1**). This would serve as a focal point of interest for park users and also provide an enhanced wildlife area. Importantly, the pond would not be connected directly to the adjacent canal to prevent colonisation by fish to ensure its function as a dragonfly and amphibian pond.

The creation of a small pond (e.g. 3.5m x 10m in size) would provide a basin that would attract aquatic invertebrates, aquatic plants and amphibians (**Plate 4.6 and 4.7**). If built correctly, the pond would require little interference over time but may require periodic clearance of aquatic and or encroaching terrestrial vegetation to maintain pockets of open water habitat. During pond excavation, it would be important to ensure that the centre of the pond had a minimum depth of 0.5m to ensure sufficient water depth during dry summers. The sides of the pond should be gently sloping to allow access to the water for wildlife, whilst also addressing public safety concerns. The base of the pond should be lined with a geotextile clay liner (GCL) or puddle clay. Commonly used butyl pond liners are not recommended given their propensity to leakages and slowed rate of biodiversity establishment. Native aquatic vegetation could be introduced from the Royal Canal as a donor site nearby or left to naturally colonise. This should be undertaken and supervised by a suitably qualified ecologist in consultation with the National Parks and Wildlife Service (NPWS) local ranger.

The dominant amenity grassland habitats of Shandon Gardens are of very poor value for hibernating amphibians. Thus, the pond margins should have amphibian hibernacula (winter refugia) installed to improve the overall value for common frog and smooth newt (Ireland's two most widespread amphibian species). Suitable hibernacula would consist of small dry stone rock structures capped with grass sods (e.g. **Plate 4.7**). Guidance of suitable hibernacula and their placement in the vicinity of the pond can be sought from an experienced ecologist. These structures are easily and cheaply constructed, flexible in their design and could be installed by members of the local community, including school children. The grass sods on the top of hibernacula can be planted with wildflower mixes, further improving their biodiversity value and incorporation into the surrounding landscape. Biodiversity signage, similar to that outlined in section 4.1.1 above could also be placed around the pond. Grassland sine mowing of the pond perimeters will maximise vegetation growth biodiversity gains and minimise disturbance-related impacts to the pond habitat while improving the overwintering value for amphibians.

Plate 4.6 Example of a small, shallow amphibian pond constructed by Triturus in Co. Cork (2020)

Plate 4.7 An example of a recent biodiversity/wetland pond creation in Watergrasshill, Co. Cork showing installation of a dry-stone, grass-capped hibernacula in foreground (credit: Triturus)

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