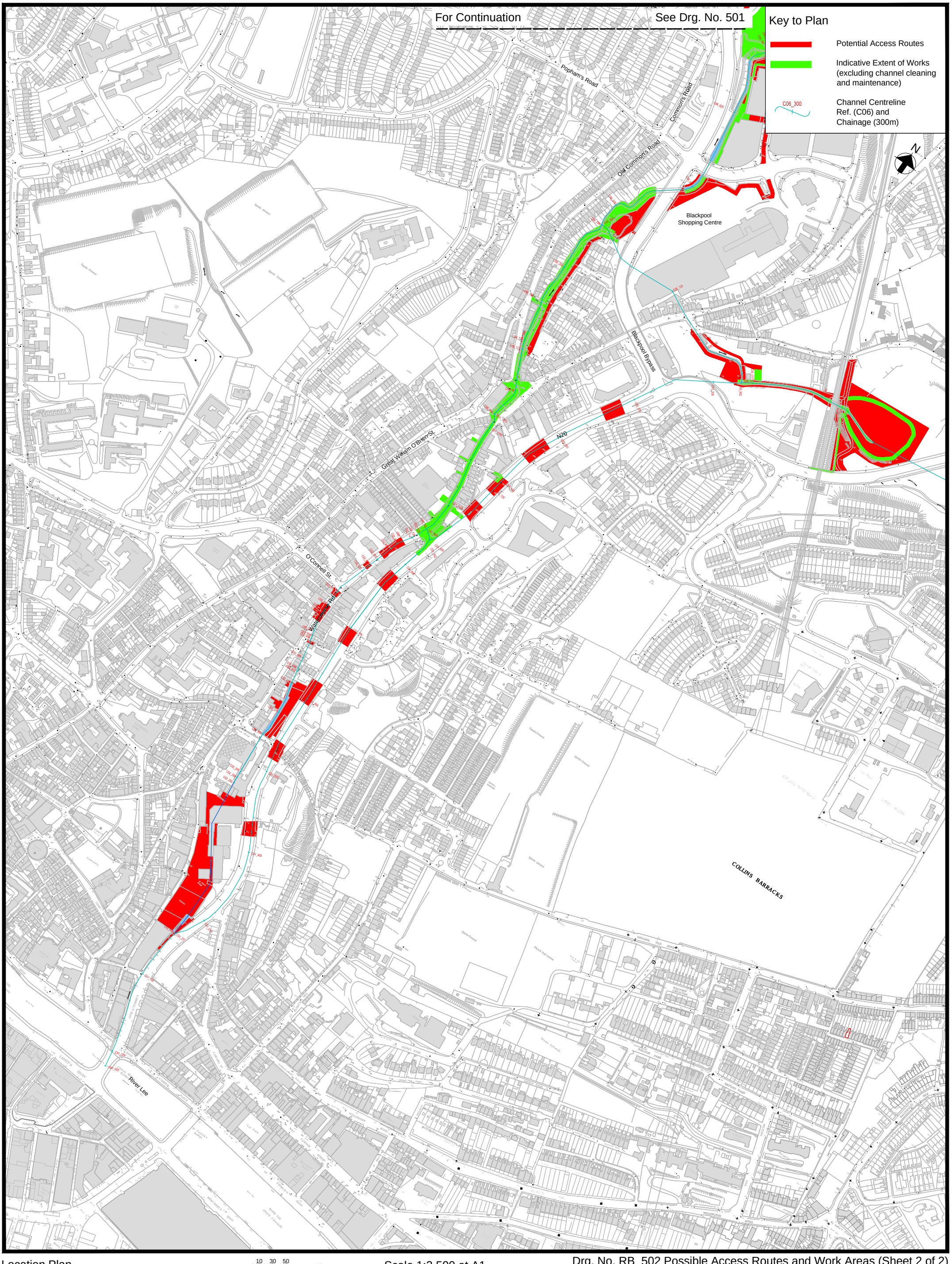

Location Plan

0 10 20 30 40 50 100 Metres

Scale 1:2,500 at A1
Scale 1:5,000 at A3

Drg. No. RB_502 Possible Access Routes and Work Areas (Sheet 2 of 2)

Notes:
1. Do not scale from drawing.
2. Proposed works geometry and extents are subject to detailed design.
3. This drawing should be read in conjunction with all other River Bride (Blackpool) Certified Drainage Scheme Exhibition Drawings and Schedules.

ARUP
Ove Arup & Partners Ireland Ltd.,
15 Oliver Plunkett Street,
Cork,
Tel +353 (0)21 4277670
Fax +353 (0)21 4272345

JBA consulting
24 Grove Island,
Corbally,
Co Limerick,
Ireland.
Tel. + 353 (0) 61 345463
Fax.+ 353 (0) 61 280146

Cork City Council,
City Hall, Anglesea Street,
Cork, Ireland.
Tel. +353 21 4966222.
Fax +353 21 4314238.

Cork County Council Headquarters,
County Hall,
Carrigrohane Road,
Cork, Ireland.
Tel: + 00 353 (0) 21 4276891
Fax: + 00 353 (0) 21 4276321

OPW
51 St. Stephens Green,
Dublin 2,
Ireland.
Tel +353 1 647 6000
Fax +353 1 661 0747

Appendix 5A
River Lee Q Sampling

Lower River Lee & Tributaries Biological Q-Sampling Report

Prepared for Ryan Hanley Consulting Engineers

April 2015

JOB NUMBER: APR02			
Version	**Originated**	**Checked**	**Date**
Draft For Comment	**Ross Macklin**	**Bill Brazier & Ross Macklin**	**22nd-4th- 2015**
Revised Draft	**Ross Macklin**	**Bill Brazier & Ross Macklin**	**22nd-4th- 2015**
Final Draft	**Ross Macklin**	**Bill Brazier & Ross Macklin**	**22nd-4th- 2015**

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1. Water Quality Assessment

Introduction

1.1 Triturus Environmental Services were contracted by Ryan Hanley Consulting Engineers to conduct a biological Q sampling report on the River Lee and several of its tributaries, Co. Cork. These surveys were commissioned as part of the ecological works prepared to establish baseline biological water quality for the Environmental Impact Statement (EIS) prepared for the Lower Lee Flood Relief Scheme. A number of discrete proposed works areas are located along the River Lee and selected tributaries, where planned work activities include the installation of flood prevention walls. Water quality survey sites were, where feasible, selected relevant to these proposed works areas.

1.2 Baseline water quality was collected specifically from the main channel of the River Lee and on the following selected tributaries; Curraheen, Glasheen, Bride [North] and Glenamought Rivers all of which to varying degrees have flood protection works proposed.

1.3 The biological water quality collected would provide baseline readings against which future water quality targets could be gauged. These values should not deteriorate as a result of works associated with the project. According to the Water Framework Directive (2000/60/EEC) target 'good status' i.e. Q4 is required in all Irish Rivers.

1.4 The biological water quality data was collected by Ross Macklin of Triturus Environmental Services during base flow water conditions between the 2nd and 5th of April 2015.

Background

1.5 The Rivers Lee (EPA code: IE_SW_19_1663), Curraheen (IE_SW_19_1744), Glasheen (IE_SW_19_1744), Bride [North] (IE_SW_19_1451) and Glenamought (IE_SW_19_1520) are located in hydrometric area 19 and within the South Western river basin district (SWRBD).

1.6 The Lee, which drains an area of 1253km2, is underlain by a mixed geology of Devonian old red sandstones and Dination mudstones and sandstones, with occasional, highly localised strikes of Tournasion limestone (Geological Survey of Ireland). The Bride (North) and Glenamought tributaries also flow over these geologies. The underlying geologies of the Curraheen and Glasheen Rivers, however, are more dynamic, consisting of intermittent Visean limestone and shale, Waulsortian mudbank limestone with limited Tournasian argillaceous biolclastic limestone (Geological Survey of Ireland).

1.7 The River Lee, Bride (North), Curraheen and Glasheen Rivers are considered lowland depositing watercourse (FW2; Fossit, 2000). The Glasheen, Bride and lower Curaheen River tributaries of the River Lee flow through the urban environment of Cork City, and as a consequence have been modified in terms of channel morphology and natural flow regimes. Overall, the Glenamought, with its steeper gradient and higher flow rate, represents a more typical eroding/upland river (FW1) and remains largely unaltered as it does not suffer from urban encroachment and associated point sources of pollution.

Statement of Authority

1.8 Ross Macklin BSc. Dip GIS is an environmental scientist who specialises in freshwater and fisheries ecology, in addition to informing engineering solutions for construction works on rivers, including site improvement and rehabilitation. He has ten years professional experience

and has surveyed over 500 different Irish river and lakes. Ross's expertise includes aquatic invertebrate and macrophyte studies in addition to fisheries quantification in a variety of surface water habitats. He routinely undertakes physiochemical water quality monitoring and biological quantification of receiving waters based on macro-invertebrate species composition using a number of biotic indices systems, including but not limited to PSYM, BMWP, SSRS and Q-Analysis. Ross has worked on multi-million euro infrastructural projects, undertaken IPPC licensing reports, acted as an ecological clerk (supervisor) of construction works and conducted numerous fisheries and ecological studies in support of a wide range of developments. He also has worked on ecological design for habitat creation projects, construction environmental management plans, method statements and site rehabilitation. Most recently he assessed the projected impacts of the implementation of Food Harvest 2020 on water quality. Ross is also completing a PhD on cyprinid ecology in U.C.C.

Methodology

1.9 Macro-invertebrate samples were collected on the River Lee and tributaries Curraheen, Glasheen, Glenamought and Bride between the 2nd and 5th May 2015 (see Figure 1.1 below). Where possible the macro-invertebrate sampling stations were situated in the vicinity upstream or downstream of the works areas, given the selection of the sampling sites also depended on the presence of riffle/ glide habitat from which samples could be collected. No samples were collected in the tidal reaches of the river, i.e. north channel of the River Lee (full extent of channel) or downstream of the Gillabey Rock on the south channel as these areas are tidal and are outside the scope of the EPA Q-Value system.

1.10 Macro invertebrate samples were collected by 'kick' sampling for approximately 2.5 minutes in the faster flowing areas (riffles) of the river using a standard hand net (250 mm width, mesh size 500 micron). The kick sample was taken moving across the riffle zone and also involved washing large rocks from the riffle zone to ensure a full representation of the species composition from this micro-habitat type. Collected samples were elutriated, refrigerated and identified live within 24 hours of each site visit. The samples were identified using a Nikon SMZ 1000 stereo microscope and numerous Freshwater Biological Association invertebrate keys. Live sorting of invertebrates facilitates improved detection of small cryptic prey items. Identified samples were then fixed in 70% ethanol in the laboratory. Invertebrate taxa were identified to species level where possible. The relative proportions of taxonomic groups were recorded based on the EPA categories (i.e. 8 categories ranging from present to excessive) (Appendix I of Toner *et al*., 2005[1]).

Table 1.1 – Location of macro-invertebrate sampling locations on the River Lee & tributaries

Site No.	River Name	Location	GPS Co-ordinates
Site 1	River Lee	Inniscarra Graveyard	W 56461 70943
Site 2	River Lee	Grotto	W 62992 71957
Site 3	River Lee	Downstream County Hall	W 65373 71319

[1] Toner, P., Bowman, J., Clabby, K., Lucey, J., McGarrigle, M., Concannon, C., Clenaghan, C., Cunningham, P., Delaney, J., O'Boyle, S., MacCarthaigh, M., Craig, M. & Quinn, R. (2005). Water Quality in Ireland 2001-2003. Environmental Protection Agency, Wexford.

Site 4	Curraheen River	Concrete Works	W 63035 71218
Site 5	Curraheen River	GAA pitches	W 64179 71289
Site 6	Glasheen River	R608	W 65358 70859
Site 7	Glasheen River	Orchard Road	W 65182 71117
Site 8	Glenamought River	Viaduct	W 66461 75061
Site 9	Glenamought River	Ind. Estate	W 66250 74765
Site 10	River Bride	Commons Inn	W 66499 74563
Site 11	River Bride	Orchard Court	W 67371 73426

Plate 1 – Nikon SMZ1000 microscope with LED lighting used in the identification of samples

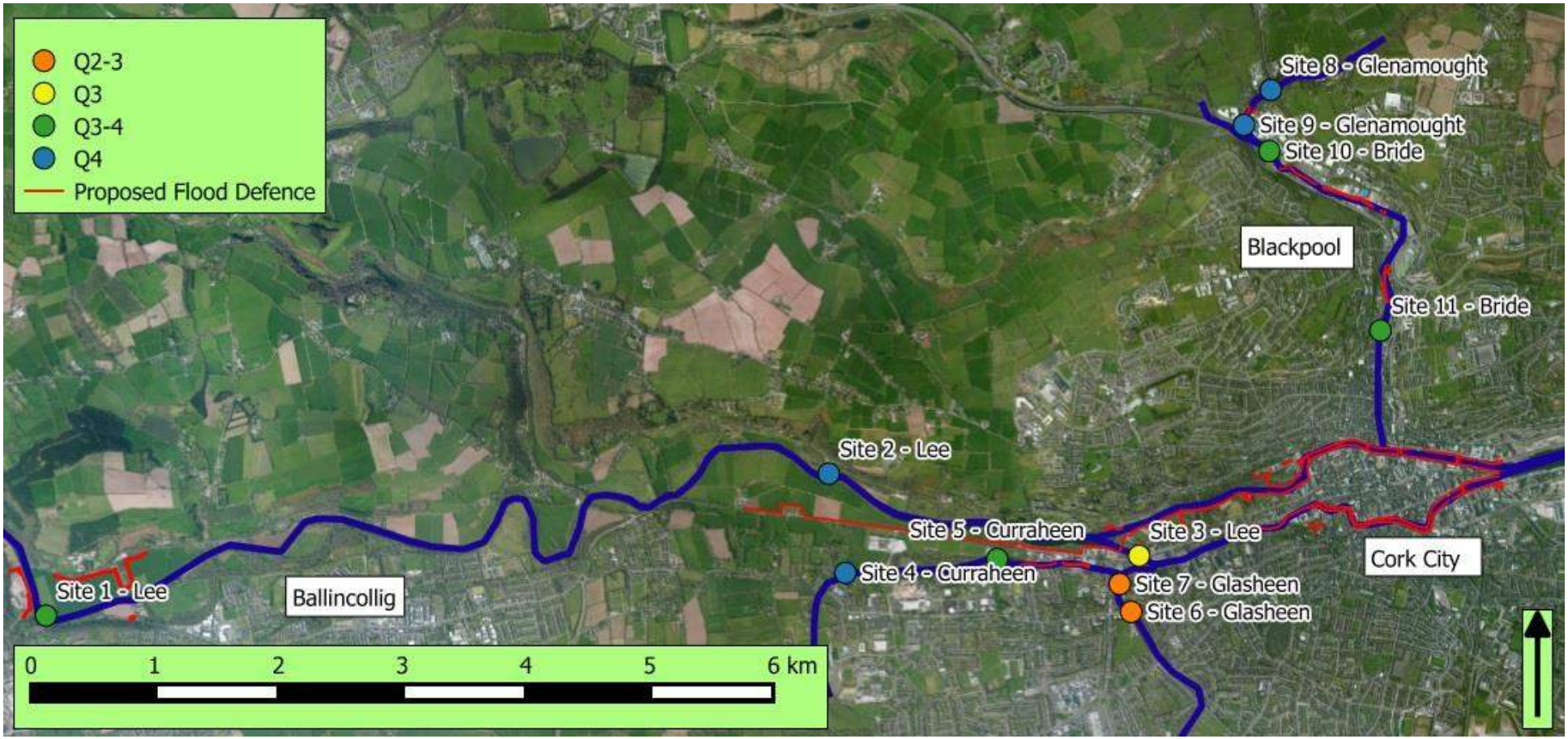

Figure 1.1 - Location of Water Quality Sampling Sites with determined Q Ratings

Results

Existing Water Quality Records

1.11 According to the EPA, the biological water quality on the River Lee achieved Q4, 'good status' at Leemount Bridge (Station RS19L030700) during 2011, which indicates it is meeting the requirements of the Water Framework Directive (2000/60/EEC). Biological water quality data for the other tributaries (i.e. Curaheen, Glasheen, Bride and Glenamought are absent). The water quality of fifteen sites on the Curraheen River was assessed as ranging from Q3-4 according to Kelly et al. (2007). However, under the South West River Basin District Management Plan, the water quality of the Curraheen River is designated as poor and it is an objective to restore this water body to good status by 2015. No other biological water quality data is available for the selected tributaries in the survey.

2015 Water Quality Data (this report)

1.12 Biological water quality data as prescribed by the Environmental Protection Agency (EPA; Toner et al. 2005), group invertebrates into classes whereby very pollution intolerant species are denoted class A, and species with greater pollution tolerance fall into successive classes (B through E respectively). As such the presence or absence of these groups and their relative abundances facilitates an assessment of biological river health. Our results are discussed in this context in order to interpret potential changes in the river community composition. See Figure 1.1 above for locations and Figure 1.2 below for a summary of the findings for each of the sites surveyed (i.e. sites 1-11). Tables 1.1 and 1.2 list all of the species recorded and show by colour separation the EPA taxonomic classes as prescribed above.

1.13 Sites 1-3 were located on the main channel of the River Lee. The furthest upstream sample (i.e. site 1) was located downstream of Inniscarra Dam near Inniscarra Graveyard. The composition of the sample had low numbers of pollution intolerant class A invertebrates, an absence of class B invertebrates (also pollution intolerant), and a dominance of class C invertebrates (more pollution tolerant).

1.14 The class A invertebrates included two stonefly species, a single specimen of *Isoperla grammatica* and 2 no. *Amphinemura sulcicollis*. The very pollution tolerant class D was also found in high numbers for two invertebrate species, the freshwater hoglouse, *Asellus aquaticus* and the bivalve *Pisidium amnicum*. The presence of small numbers of class A invertebrates and the dominance of class C, coupled with high numbers of two pollution tolerant invertebrates in class D indicated that the sample was representative of a Q3-4 slightly polluted site.

1.15 Site 2 on the River Lee was located adjacent to the Grotto on the back Lee Road. The site had high numbers of the flattened mayfly species *Heptagenia sulphurea* (class A very clean water species), with lesser numbers of the very clean water (class A) stonefly species *Isoperla grammatica* and *Chloroperla torrentium*. However the pollution tolerant invertebrate species *Asellus aquaticus* (class D) was also present in good numbers and indicative of some level of pollution. Nonetheless, the presence of a high diversity of species in the sample (N=15) coupled with the presence of clean water mayfly and stonefly species indicates the sample is representative of unpolluted Q4 (good status) water quality.

1.16 Site 3 on the River Lee was located downstream of the County Hall Weir adjacent to a small footbridge on the suburbs of Cork City. The absence of very clean water (Class A) and clean water (Class B) invertebrates indicated lower quality water. The sample was dominated by class C (moderately pollution tolerant) invertebrate species including caseless caddis species

Hydropsyche augustipennis and *Oecetis ochracea.* Other class C invertebrate species included the gastropod snails *Planorbis planorbis* and *Valvata piscinalis.* The presence of the class D pollution tolerant invertebrate forms representing the leech species *Helobdella stagnalis* and the bivalve snail *Sphaerium corneum,* further indicated that the sample was representative of a Q3 moderately polluted watercourse.

1.17 Sites 4 and 5 were located on the Curraheen River tributary of the River Lee. Site 4 was located in the vicinity of the old concrete works downstream of Carrigrohane Bridge, while site 5 was located adjacent to the GAA pitches further downstream. Site 4 had good numbers of class A invertebrate species present including the flattened mayfly species *Rhithrogena semicolorata* and the stonefly species *Brachyptera risi* and *Chloroperla torrentium*. Site 4 also has the large cased caddis species *Anabola nervosa* and the smaller stone cased species *Goera pilosa* present (both clean water class B invertebrates). The presence of a very high species diversity (N=19), good numbers of class A invertebrates and low numbers of pollution tolerant invertebrates accounted for a Q rating of 4 (i.e. unpolluted water; i.e. good status) at site 4 on the Curraheen River. Site 5 further downstream on the Curraheen River had only one class A species present (i.e. *Heptagenia sulphurea*) in low relative abundance. Site 5 on the Curraheen River also had higher numbers of the water pollution tolerant crustacean *Asellus aquaticus* which together accounted for a lower Q rating of Q3-4 (i.e. moderate status) than that recorded at site 4.

1.18 Sites 6 and 7 where located on the Glasheen River. The river was heavily encroached by the urban surrounds of Cork City and suffered from numerous point sources of pollution including storm drains. No EPA class A or B clean water invertebrates were found present in the samples collected. The samples were dominated by class C, D and E invertebrates indicating a clear shift in the invertebrate community towards more pollution tolerant forms. These included the (class D) crustacean *Asellus aquaticus* in very high numbers, and class E *Tubificid* sp. worms and the non-biting midge species *Chironomus riparius*. The dominance in the sample of pollution tolerant invertebrates accounted for a Q rating of 2-3 (i.e. poor status).

1.19 Sites 8 and 9 were located on the Glenamought River, a more high gradient and natural river on the outskirts of Cork City, between the townlands of Kilnap and Glenamought. Both sites had a good diversity of clean water stoneflies and mayflies present including the mayfly species *Rhithrogena semicolorata, Heptagenia sulphurea* and *Ecdyonurus torrentis*. The stonefly species recorded between the two sites included *Brachyptera risi, Isoperla grammatica* and *Chloroperla torrentium.* Together the good diversity of stoneflies and mayflies indicates good quality water. Pollution tolerant invertebrate forms were virtually absent apart from the leech species *Haemoptis sanguisuga* (class D) at site 9. In summary the invertebrate composition encountered at sites 8 and 9 were representative of Q4 unpolluted, good status water quality.

1.20 Sites 10 and 11 were located on the River Bride (of which the Glenamought is a tributary). The River Bride was located on a more modified section of the river where urban encroachment and point sources of pollution were evident. Some localised realignment of the channel was also evident. Only small numbers of very clean water (class A) invertebrates were present at sites 10 and 11, while only one species from class B was present (also indicative of clean water). Sites 10 and 11 were dominated by class C (moderately pollution tolerant) invertebrate species that included good numbers of the mayfly species *Baetis rhodani*, a mayfly species characteristic of slightly polluted waters. In summary the water quality at sites 10 and 11 on the River Bride were indicative of Q3-4 moderate status, slightly polluted water.

1.21 Water quality in the River Lee and tributaries Curraheen, Glasheen, Glenamought & Bride can be summarized as follows (see Figure 1.1 above for locations);

- Site 1 (River Lee, Iniscarra Graveyard) **Q3-4 Slightly Polluted (Moderate Status)**
- Site 2 (River Lee, Grotto, Back Lee Road)) **Q4 Moderately Polluted (Poor Status)**
- Site 3 (River Lee, downstream County Hall) **Q3 Moderately Polluted (Poor Status)**
- Site 4 (Curraheen River, Concrete Works) **Q4 Unpolluted (Good Status)**
- Site 5 (Curraheen River, GAA Picthes) **Q3-4 Slightly Polluted (Moderate Status)**
- Site 6 (Glasheen River, R608) **Q2-3 Seriously-Moderately Polluted (Poor Status)**
- Site 7 (Glasheen River, Orchard Road) **Q2-3 Seriously-Moderately Polluted (Poor Status)**
- Site 8 (Glenamought River, Viaduct) **Q4 Unpolluted (Good Status)**
- Site 9 (Glenamought River, Ind. Park) **Q4 Unpolluted (Good Status)**
- Site 10 (River Bride, Commons Inn) **Q3-4 Slightly Polluted (Moderate Status)**
- Site 11 (River Bride, Orchard Court) **Q3-4 Slightly Polluted (Moderate Status)**

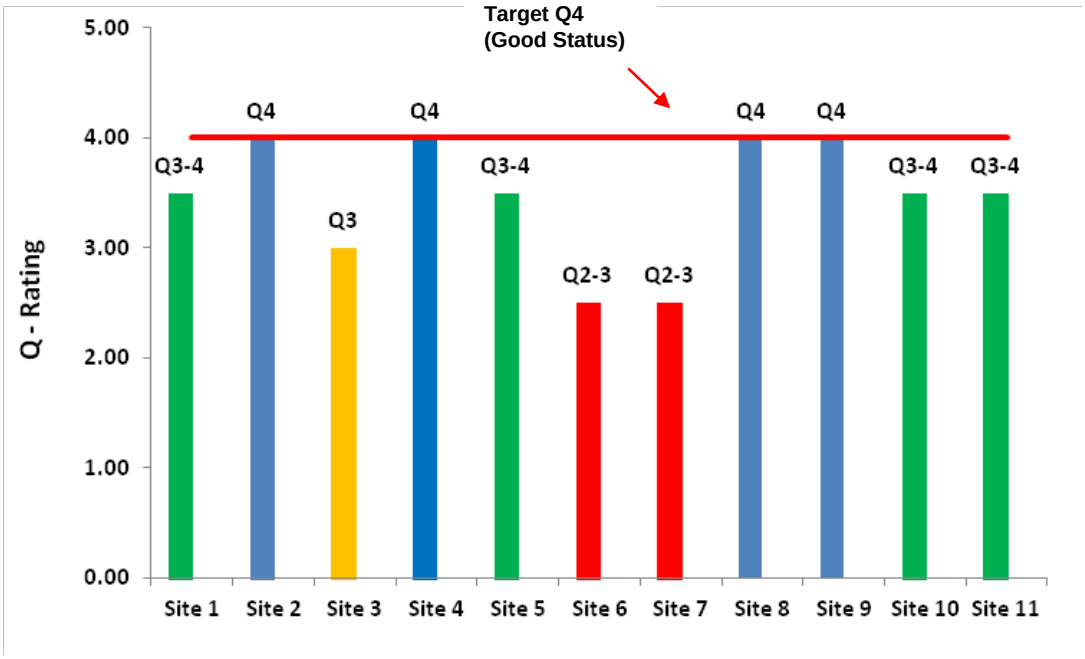

Figure 1.2 – Biological Q-Ratings on the River Lee & tributaries April 2015

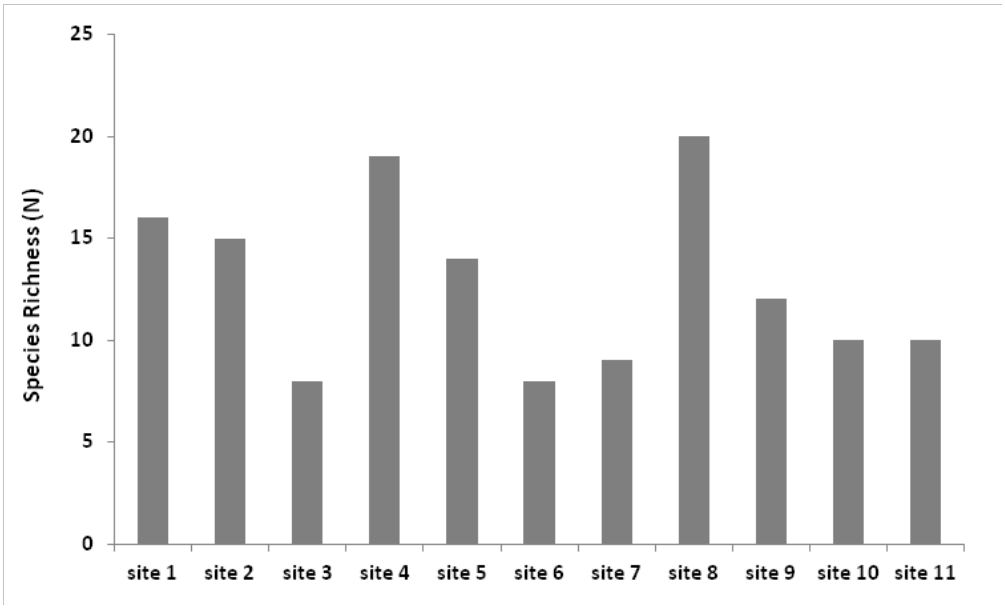

Figure 1.3 – Macro-invertebrate Species Richness (N) present in the River Lee & tributaries April 2015

Family	Species	Site 1 - Lee	Site 2 - Lee	Site 3 - Lee	Site 4 - Curraheen	Site 5 - Curraheen	Site 6 - Glasheen	EPA Class
Heptageniidae	*Heptagenia sulphurea*		12			2		A
	Rhithrogena semicolorata				22			A
Nemouridae	*Amphinemura sulcicolis*	2						A
Taenyopterigdae	*Brachyptera risi*				3			A
Perlodidae	*Isoperla grammatica*	1	1					A
Chloroperlidae	*Chloroperla torrentium*		2		5			A
Limnephilidae	*Anabola nervosa*				3	2		B
Goeridae	*Silo palipes*				1			B
Seracostomatidae	*Seracosoma personatum*					1		B
Caenidae	*Caenis lactuosa*		1					C
Baetidae	*Baetis rhodani*	3	3		16	26		C
Ephemerellidae	*Ephemerella ignita*	3						C
Ryacophilidae	*Ryacophila dorsalis*	1	1					C
Hydropsychidae	*Hydropsyche siltalai*		12		3			C
	Hydropsyche augustipennis	9		8		16		C
Polycentropodidae	*Holocentropus picicornis*	11	7					C
	Polycentropus kingi				1			C
	Oecetis ochracea			1				C
Gammaridae	*Gammarus duebenii*	7	29		14	4	6	C
Elmidae	*Elmis aenea*				2	1		C
	Limnius volkmari	2			1			C
Simulidae	*Simulium sp.*			6	4	2	2	C
Chironomidae	*Chironominae*	14						C
	Spaniotoma sp.		2			1		C
Tipulidae	*Dicranota sp.*				2			C
Lumbricinae	*Eiseniella sp.*			1				C
Lymnaeidae	*Lymnaea stagnalis*		3			2	3	C
Valvatidae	*Valvata piscinalis*		1	4				C
Ancylidae	*Ancylus fluviatilis*		23		6			C
Hydrobiidae	*Hydrobia ventrosa*	1						C
Planorbidae	*Planorbis planorbis*	1		1				C
Pisciolidae	*Pisciola geometrica*				1			C
Flatworm	*Polycelis nigra*	3			2	4	6	C
Hydracarina	*n/a*				1			C
Lymnaeidae	*Lymnaea peregra*	1						D
Sphaeridae	*Pisidium amnicum*	15						D
	Spharium sp.						3	D
	Spharium corneum			8				D
Glossiphoniidae	*Helobdella stagnalis*		1	2				D
Erpobdellidae	*Erpobdella octoculata*				1	1		D
Asellidae	*Asellus aquaticus*	13	15		2	11	42	D
Chironomidae	*Chrionomus riparius*					1	5	E
Tubificidae	*Tubificid sp.*						14	E
	Taxon Richness N	**16**	**15**	**8**	**19**	**14**	**8**	
	Q Rating	**Q3-4**	**Q4**	**Q3**	**Q4**	**Q3-4**	**Q2-3**	

Table 1.1 – Macro-invertebrate composition at sites 1-6 on the River Lee, Curraheen & Glasheen

Family	Species	Site 7 - Glasheen	Site 8 - Glenamought	Site 9 - Glenamought	Site 10 - Bride	Site 11 - Bride	EPA Class
Heptageniidae	*Heptagenia sulphurea*		1				A
	Rhithrogena semicolorata		18	7		2	A
	Ecdyonurus torrentis			1			A
Nemouridae	*Amphinemura sulcicolis*		2	4		2	A
Taenyopterigdae	*Brachyptera risi*			3			A
Perlodidae	*Isoperla grammatica*		2		1		A
Chloroperlidae	*Chloroperla torrentium*			1		1	A
Limnephilidae	*Halesus radiatus*		3				B
	Limnephilus sp.			1			B
Goeridae	*Silo palipes*		1				B
Seracostomatidae	*Seracosoma personatum*		1		1		B
Baetidae	*Baetis rhodani*	2	31	11	8	32	C
Ephemerellidae	*Ephemerella ignita*		5	2	2		C
Ryacophilidae	*Ryacophila dorsalis*		2		1		C
Hydropsychidae	*Hydropsyche siltalai*		6	6	2	5	C
Polycentropodidae	*Holocentropus picicornis*		1		2		C
Gammaridae	*Gammarus duebenii*	7	11	7	22	2	C
	Limnius volkmari		2				C
Gyrinidae	*Gyrinus sp.*		1				C
Simulidae	*Simulium sp.*		3			3	C
Chironomidae	*Chironominae*		1			27	C
	Spaniotoma sp.		24				C
Lumbricinae	*Eiseniella sp.*				1	1	C
Lymnaeidae	*Lymnaea stagnalis*	1					C
Ancylidae	*Ancylus fluviatilis*		2	1		2	C
Hydrobiidae	*Hydrobia ventrosa*	1					C
	Potamopyrgus antipodarum		1				C
Flatworm	*Polycelis nigra*	2					C
	Spharium sp.	11					D
Hirudinea	*Haemoptis sanguisuga*			1			D
Asellidae	*Asellus aquaticus*	55					D
Chironomidae	*Chrionomus riparius*	4			16		E
Tubificidae	*Tubificid sp.*	7					E
	Taxon Richness N	**9**	**20**	**12**	**10**	**10**	
	Q Rating	**Q2-3**	**Q4**	**Q4**	**Q3-4**	**Q3-4**	

Table 1.2 – Macro-invertebrate composition at sites 7-11 on the Rivers Glasheen, Glenamought & Bride.

Discussion

1.22 Currently the overall water quality on the River Lee main channel is achieving target Q4 good status as required under the Water Framework Directive, at only one of the three sites surveyed on the River Lee (i.e. site 2). The remaining 2 sites surveyed (i.e. sites 1 and 3) are achieving slightly polluted (Q3-4) and moderately polluted (Q3) water respectively. As such both sites have moderate status and are not achieving the target Q4 good status water quality required under the Water Framework Directive. It is likely that diffuse agricultural enrichment in addition to waste water point sources are contributing to the localised declines in water quality of the River Lee. Future improvement in water quality may push longer longitudinal reaches of the river channel into the good status (Q4) category.

1.23 The Curraheen River was achieving good status Q4 water quality at site 4 (concrete works) but deteriorated slightly downstream at site 5 (GAA pitches) where slightly polluted water (Q3-4) was recorded. The Curraheen River historically has suffered from pollution from waste water outfalls upriver and the recorded Q measurements appear to indicate an improvement in water quality. Very healthy salmonid and lamprey stocks were also recorded during surveys in 2014 indicating a healthy river overall. Should the trends continue to improve the water quality may achieve good status over a longer reaches of the channel.

1.24 The Glasheen River tributary of the River Lee had the poorest water quality of all of the river sites surveyed on the lower River Lee and tributaries. There was evident abundant blanket *Cladophora* weed and some localised patches of sewage fungus present on the Glasheen River along much of the channel. The River was heavily encroached by the suburbia of Cork City and had numerous storm drains and other point sources of pollution. It was evident from the discoloration in the water and smell from these outfalls that they were contributing to the recorded poor water quality at sites 6 and 7 (i.e. Q2-3 poor status water).

1.25 The Glenamought River was among the cleanest of the river sites surveyed with Q4, good status water quality recorded at both sites 8 and 9 surveyed on the river channel. The Gleanamought River was located in a non urbanised environment and rises in a wooded river valley with limited human interference. The river retained a very natural profile with riffle, glide and pool habitat. While some localised realignments have occurred in its lower reaches the water quality appears to be unaffected. The Glenamought River between the Viaduct and the Industrial Estate downstream near its confluence with the River Bride had very high densities of salmonids as observed during electro-fishing surveys in 2014. The river had clean swift flowing water and clean substrata which evidently have helped maintain the rivers unpolluted status (i.e. good status Q4 water quality at sites 7 & 8).

1.26 Further downstream on the River Bride (sites 10 and 11) the water quality deteriorated. This was likely as a result of urban encroachment and associated storm drain point sources of pollution (pers. obs.) that are entering the river. As such the water quality was recorded as Q3-4 slightly polluted (moderate status). Fortunately the strong flow volumes and the remaining pockets of semi-natural channel are helping to maintain the river in a category that has the capacity to improve to target Q4 (i.e. from moderate status to good status). Further improvements in water quality by means of the detection and control of point sources may help the river achieve good status in the future.

1.27 It is recommended that future biological water quality surveys are undertaken on the River Lee and tributaries during the construction and operational phases of the proposed flood relief works to ensure that the status quo of the baseline water quality is maintained before and after construction.

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Appendix 5B
River Lee Electrofishing Report

OFFICE OF PUBLIC WORKS

LOWER LEE FLOOD RELIEF SCHEME

LOWER LEE ELECTRO-FISHING SURVEY & LICENSE RETURN REPORT

April 2015

RYAN HANLEY
CONSULTING ENGINEERS
Sherwood House, Sherwood Avenue, Taylor's Hill, Galway
170 Ivy Exchange, Granby Place, Parnell Square West, Dublin 1

Report Control Sheet

CLIENT	Office of Public Works
PROJECT NO	2365
PROJECT TITLE	Lower Lee Flood Relief Scheme
REPORT TITLE	Lower Lee Electro-fishing Survey & License Return Report

REV.	STATUS	AUTHOR(S)	REVIEWED BY	APPROVED BY	ISSUE DATE
0	Issued to Client	Ross Macklin, Bill Brazier, Thomas Kavanagh.	Jonathan Reid, Lisa Dolan, Sarah Mullen,	Michael Joyce	24/04/2015

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1. Introduction

Triturus Environmental Services was contracted by Ryan Hanley Consulting Engineers to conduct a number of fisheries surveys on the River Lee and several of its tributaries, Co. Cork. These surveys were commissioned as part of the overall Lower Lee Flood Relief Scheme, which aims to address the excessive flooding of the rivers in the vicinity of Cork City. A number of discrete proposed works areas are located along the River Lee and selected tributaries, where planned work activities include the installation of flood prevention walls. Survey sites were, where feasible, were selected relevant to these proposed works areas.

The purpose of the surveys was to assess the overall fisheries habitat value in the lower River Lee (from Iniscarra Hydroelectric Dam, downstream) and selected tributaries (i.e. Curraheen, Glasheen, Bride [North] and Glenamought Rivers), particularly in relation to Annex II lamprey and salmonid species.

Ryan Hanley Consulting Engineers obtained a Section 14 Authorisation on the 27th September 2014, under the Fisheries Consolidation Act 1959, as substituted by section 4 of the Fisheries (Amendment) Act 1952, to conduct an electro-fishing assessment of the River Lee and selected aforementioned tributaries, Co. Cork. As agreed with Inland Fisheries Ireland, Ross Macklin and Bill Brazier of Triturus Environmental Services were commissioned to undertake the surveys by electro-fishing as appointed by Lisa Dolan of Ryan Hanley.

The baseline data and results of the surveys would help inform the detailed design and mitigation for the proposed flood relief works along the lower River Lee and selected tributaries, namely the Curraheen, Glasheen, Bride (North) and Glenamought Rivers.

Background

The Rivers Lee (EPA code: IE_SW_19_1663), Curraheen (IE_SW_19_1744), Glasheen (IE_SW_19_1744), Bride [North] (IE_SW_19_1451) and Glenamought (IE_SW_19_1520) are located in hydrometric area 19 and within the South Western river basin district (SWRBD).

The Lee, which drains an area of 1253km^2, is underlain by a mixed geology of Devonian old red sandstones and Dination mudstones and sandstones, with occasional, highly localised strikes of Tournasion limestone (Geological Survey of Ireland). The Bride (North) and Glenamought tributaries also flow over these geologies. The underlying geologies of the Curraheen and Glasheen Rivers, however, are more dynamic, consisting of intermittent Visean limestone and shale, Waulsortian mudbank limestone with limited Tournasian argillaceous biolclastic limestone (Geological Survey of Ireland).

The Lee is a lowland depositing watercourse (FW2; Fossit, 2000). It may be considered a 'C type' channel in its lower reaches (Rosgen, 1996). C type channels are meandering in character, their banks low enough to provide regular flooding and are excellent nursery and spawning rivers.

The Bride (North), Curraheen and Glasheen can also be classed as lowland depositing watercourses (FW2). As these three tributaries flow through the urban environment of Cork City and surrounds, they have been largely altered and modified in terms of channel morphology and natural flow regimes. Overall, the Glenamought, with its steeper gradient and higher flow rate, represents a more typical eroding/upland river (FW1).

According to the EPA the biological water quality on the River Lee achieved Q4, 'good status' at Leemount Bridge (on the R618 road) during 2011, which indicates it is meeting the requirements of the Water Framework Directive (2000/60/EEC). Water quality data for the selected tributaries is largely lacking. The water quality of fifteen sites on the Curraheen River was assessed as ranging from Q3-4 according to Kelly *et al*. (2007). However, under the South West River Basin District Management Plan, the water quality of the

Curraheen River is designated as poor and it is an objective to restore this water body to good status by 2015.

No other water quality data is available for the selected tributaries in the survey although the urban reaches of all these rivers are considered to be particularly under threat from pollution.

The River Lee is a designated salmonid watercourse under S.I. No. 293/1988 - European Communities (Quality of Salmonid Waters) Regulations, 1988. The River Lee contains 1.01% of the fluvial accessible habitat to Atlantic salmon (*Salmo salar*), ranking it 22nd nationally according to the Quantification of the Freshwater Salmon Habitat Asset in Ireland (McGinnity *et al.*, 2003).

The Bride, and its Glenamought tributary, are both considered impassable to migratory Atlantic salmon due to urban modification (culverted from Blackpool to River Lee confluence). However, both rivers are known locally to support moderate stocks of wild Brown trout (*Salmo trutta*). In contrast, due to more direct connectivity with the south channel of the River Lee (Cork City), the Curraheen is locally known to support stocks of Atlantic salmon.

2. Methods

Study Site

Electro-fishing surveys of the existing fish stocks at selected sites on the Rivers Lee (n=2), Curraheen (n=3), Glasheen (n=1), Bride (North) (n=3) and Glenamought (n=1), Co. Cork, were conducted over the 27-30th September 2014. Where feasible, sites were selected in relation to proposed works areas along the respective river channels (Fig 2.1). Site selection on the River Lee was constrained largely by river depth, with the majority of the river in the vicinity of works areas deemed unsuitable (i.e. too deep) for safe and effective wadable/bank electro-fishing. Safe access rather than depth was a particular issue on the Curraheen and Bride (North) rivers, although sites were chosen to provide as broad a characterisation as possible along the length of channels relevant to the proposed works areas. With regards to the Glasheen and Glenamought, single sites were selected and surveyed to reflect the limited locations of the proposed works areas.

As two primary species groups were targeted during the electro-fishing surveys, i.e. lamprey and salmonids, two separate electrofishing methodologies were employed, incorporating different settings. For lamprey species, a 1m^2 box-quadrat was utilised, where two operator's electro-fished within the selected quadrat areas at each site (if present) in a discontinuous, upstream, manner. For salmonids, electro-fishing was conducted in an upstream direction at each pre-selected site for a standard 5 minute CPUE, after Kennedy (1984) and O' Connor & Kennedy (2002). Both approaches were conducted using a single anode Smith-Root LR24 backpack (12V DC input; 300V, 100W DC output).

Water with a low conductivity has a higher resistance to the passage of an electric current through it. This means that in high conductivity waters the current for a given voltage is higher than in low conductivity water and the threshold values for different fish responses are also lower (Zalewski and Cowx, 1990). Given this fact, conductivity (µs) was measured on-site prior to any electro-fishing activity to better inform the management of settings.

In order to minimise potential damage and undue stress to qualifying interest lamprey species and Atlantic salmon, electro-fishing settings were modified to target specific species at the site (see below). Larval

lamprey species, for example, were specifically targeted in areas of low/reduced flow and with a higher proportion of soft sediment.

Typically, salmonids require a higher frequency (and also voltage) than lamprey species in order to sufficiently stun them for capture. Unless amended, these settings can result in the inadvertent electro-narcosis of buried ammocoetes, resulting in failure to emerge and recording of absence, as well as damage to the fish (Thompson *et al.*, 2010).

Specific settings on the Smith-Root LR24 for each species utilised during the survey are outlined below.

Electrofishing settings

Lamprey species

As per Harvey & Cowx (2003), quadrat-based electro-fishing was conducted for lamprey ammocoetes. Settings for lamprey followed those recommended and used by APEM (2004) and Niven & McAuley (2013). Using this approach, the anode was placed under the water surface, approx. 10–15 cm above the sediment, to prevent immobilising lamprey ammocoetes within the sediment. The anode was energised with 100V of pulsed DC for 15-20 seconds and then turned off for approximately five seconds to allow ammocoetes to emerge from their burrows. The anode was switched on and off in this way for approximately two minutes. Immobilised ammocoetes are either carried downstream and collected in the cod end of the box quadrat, or are collected by a second operator using a fine-mesh hand net as they emerge. During this survey, a frequency of 20-25Hz was utilised, with a duty cycle of approx. 12% (pulse width 6ms).

Salmonids

As salmonids typically require a higher frequency than lamprey ammocoetes, the frequency was increased to 35-40Hz at a duty cycle of 18% when specifically targeting salmonids during these fisheries assessments (i.e. in faster glides, over gravels).

Other fish species (i.e. eels, cyprinids, percids, pike)

In the deeper water following one site pass with lamprey settings (to ensure no lamprey would be missed), a pulse width of 30 hertz and 18% duty cycle was used. Eel, cyprinids, percids and pike typically require a lower frequency than salmonids and higher than lamprey. While perch and eel may be captured at lower frequencies, these settings would offer the best capabilities to catch a wide range of fish.

Fish handling

Once immobilised, fish were quickly removed and placed in 20L oxygenated bankside water baths (battery-powered Jarvis Walker Deluxe Two-Speed Aerators) containing river water until all electrofishing passes had been completed. Fish were then anaesthetised in a 30mg/L clove oil solution and then identified to species level. Captured fish were subsequently measured to the nearest millimetre (standard length, SL for eel and lamprey; fork length, FL for all other species) and weighed to the nearest 0.1g. Lamprey ammocoetes were identified to species level, with the assistance of a hand lens, through external pigmentation patterns and trunk myomere counts as described by Potter & Osborne (1975) and Gardiner (2003). Handling of live fish was kept to a minimum when processing any captured individuals. Latex gloves were used when handling and processing all fish to minimise potential damage through slime removal and/or the spread of infection between fish. Following processing, all fish were allowed sufficient time to recover in well oxygenated water and returned to the river. All fish recovered quickly and no mortalities were observed.

Dive Survey

A dive survey was undertaken in the deep areas of channel between the Lee Fields and the Kingsley Hotel downstream of the weir, where it was unfeasible to safely or effectively electro-fish. Three 50m transecsts were covered both upstream and downstream of the weir. Underwater photography equipment was used to broadly record the fish species encountered, general abundances and to evaluate the numbers of adult salmon observed. Nikon D7100 cameras with Nauticam Housing and Ikelite DS161 strobe lighting were used to capture pictures in the turbid water.

Optimum Survey Period and seasonal sensitivities

Surveys should be conducted during the optimum survey period of the particular species of interest. This electro-fishing survey was undertaken before the end of September 2014. It is considered that by undertaking electro-fishing surveys for salmonids during or post-August that the juvenile fish (including young-of-the-year individuals) are of sufficient size to recover following a survey which was conducted according to Inland Fisheries Ireland best practice (IFI pers. comm. 2014). In addition, the metamorphosis of lamprey usually takes place between July and September. It is therefore recommended that surveys for ammocoetes are carried out in July at the earliest but preferably between August and October in order to detect the presence of transformed ammocoetes (Harvey & Cowx, 2003; National Roads Authority, 2009). As these surveys were undertaken before the end of September, brook, river (and sea) lamprey transformers were more likely to be detected, thus making the separation of river and brook species ammocoetes possible should transformers be present.

Biosecurity

All equipment and PPE used was disinfected with Virkon® prior to and post-survey completion, and best practice precautions were employed to prevent the potential spread of invasive species and water-borne pathogens between sites, according to standard Inland Fisheries Ireland (IFI) biosecurity protocols.

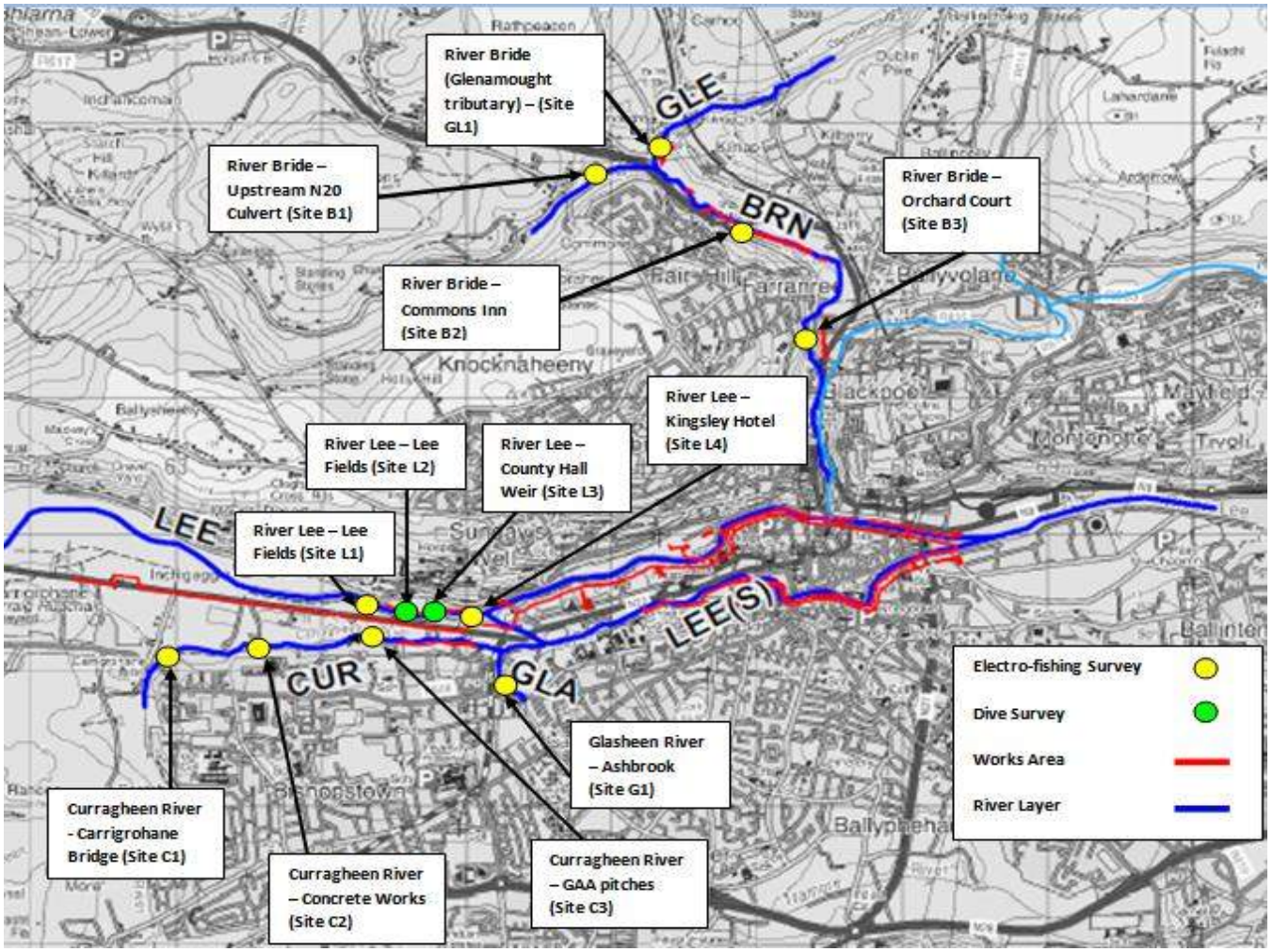

Figure 2.1:- Location of Electro-fishing and dive survey sites for the Lower Lee Flood Relief Scheme

3. Results

Riparian zone characteristics

River Lee

The River Leedownstream from Inniscarra Hydro-electric Dam is characterised by dense, often continuous riparian tree lines (WL1) on both banks, predominantly bordered by moderate quality agricultural grassland (GA1). In the vivinity of the dam some coniferous afforestation exits but downstream the treelines are largely dominated by species such as Sally willow (*Salix cinera*), grey willow (*Salix cinerea subsp. oleifolia*) alder (*Alnus glutinosa*) and ash (*Fraxinus excelsior*). Common bankside herbs and grasses included reed canary grass (*Phalaris arundinacea*), nettle (*Urtica dioica*), bramble (*Rubus fructicosus* agg.), creeping buttercup (*Ranunculus repens*), American willowherb (*Epilobium ciliatum*), purple loosestrife (*Lythrum salicaria*), common figwort (*Scrophularia nodosa*) etc. water pepper (*Persicaria hydropiper*) was particularly common in the vicinity of gravel banks. From the Anglers Rest downstream the invasive but striking looking plant Himalayan balsam (*Impatiens glandulifera*) becomes increasingly common. This pattern continues as far downstream as the Cork City boundaries at the Lee Fields.

Beyond the county hall weir the river splits into the North and South channels, with the banks becoming more modified, maintained and urbanised in general, with a greater occurrence of non-native species such as (invasive) Japanese knotweed (*Fallopia japonica*), travellers joy (*Clematis vitalba*) and buddleja (*Buddleja davidii*). Through Cork City to Tivoli Docks (estuarine habitat) the Lee is constrained by flood prevention and quay walls, which harbour species such as Maidenhair spleenwort (*Asplenium trichomanes*), pellitory-of-the-wall (*Parietaria judaica*) and buddleja (*Buddleia davidii*).

Curraheen River

The Curraheen River, features several distinct riparian zones. Downstream of Carrigrohane Bridge, its banks are relatively densely vegetated by mature crack willow (*Salix fragilis*), sally willow, sycamore (*Acer psuedoplanatus*). Alder is also present in addition to some beech (*Fagus sylvatica*). The understory species complex includes bramble, nettle, cocksfoot grass (*Dactylis glomerata*) and red-osier. Dogwood (*Cornus sericea*) is common in the middle reaches of the river downstream of the concrete works. Downstream of the playing fields at Carrigrohane the river becomes more urbanised and contained by retaining walls and a channel heavily choked by unbranched bur reed (*Sparganium emersum*) vegetation.

Glasheen River

The Glasheen River is a highly modified, urban channel, whose water quality is considered as poor. The riparian cover was dense and mostly planted given the urban encroachment on the channel. Leylandi cypress (*Cupressus x leylandii*), ash, elm (*Ulmus spp.*), buddleja, bluebell (*Hyacinthoides non-scripta*), ivy (*Hedera helix*), herb robert (*Geranium robertanium*), harts tongue fern (*Aspelnium scolopendrium*), nettle and the non-native winter heliotrope (*Petasites fragrans*). A number of localised liverwort species are present on the man-made surfaces (walls) along the river such as great scented liverwort (*Conocephalum conicum*), *Marchantia polymorpha, Pellia endiviifolia* and *Pellia epiphylla*.

River Bride (North)

Similar to the Curraheen, the River Bride can be considered by a number of distinct riparian zones, both semi-urban and urban. The less urbanised section of the river, at least in relation to survey efforts, is short and features a riparian zone containing sally willow, ash, sycamore, buddleja, bramble, Montbretia, Red bartsia (*Odontites vernus*), False oat grass (*Arrhenatherum elatius)*, etc. where it flows through agricultural

grassland (GA1). Downstream of the N20 culvert and adjacent to North Point Business Park, the river meanders naturally through an area of dry meadow and grassy verges (GS2) containing species such as meadowsweet (*Filipendula ulmaria*), sally willow, nettle, purple loosestrife, water mint (*Mentha aquatica*), bramble, cocksfoot grass, etc. From the Commons Inn (site 2) onwards, the river flows through a series of operational and derelict industrial areas and is typically retained by flood walls. Riparian species here are more typical of wasteground, such as buddleja, catsear (*Hypochaeris radicata*), etc although small patches of reed canary grass, water dropwort (*Oenanthe crocata*) etc. are also present. The Bride also flows through an area of recreational parkland (GA2 and WD5) at Blackpool retail park, with many atypical, planted and ornamental species present including Raspberry (*Rubus idaeus*). Downstream of this park, in Blackpool, the river is briefly lined by dense riparian cover from species such as sycamore, alder, birch and willow before it is culverted underground to its confluence with the River Lee at Popes Quay, Cork City. A number of non-native species are present along the Bride, including Montbretia (*Crocosmia x crocosmiiflora*), Snowberry (*Symphoricarpos albus*) and the highly invasive Japanese Knotweed.

Glenamought River

The Glenamought is the least modified river surveyed, flowing through rural areas for much of its length. The single selected site, located downstream of the viaduct on the Mallow Road was relatively heavily shaded (like much of the river) from species including beech (*Fagus sylvatica*), sycamore, hawthorn, Horse chesnut (*Aesculus hippocastanum*), willow (*Salix* spp.), buddleja, Cherry laurel (*Prunus laurocerasus*) with herbaceous species such as butterbur, Purple loosestrife and the invasive Japanese Knotweed also present.

Physical site characteristics

Site-specific physical characteristics for each river surveyed as part of the fisheries assessment i.e. Lee, Curaheen, Glasheen, Bride & Glenamought, are summarised in Tables 3.1, 3.2 and 3.3 below.

Characteristic	Lee Road (site L1)	Salmon Weir (u/s) (site L2)	Salmon Weir (d/s) (site L3)	d/s Kingsley Hotel (site L4)
Section Profile	% Riffle:- 0 % Glide:- 100 % Pool:- 0	% Riffle:- 0 % Glide:- 90 % Pool:- 10	% Riffle:- 20 % Glide:- 20 % Pool:- 60	% Riffle:- 0 % Glide:- 90 % Pool:- 10
Salmonid habitat quality	**Nursery –** Moderate **Spawning –** Good **Holding –** Moderate	**Nursery –** Poor **Spawning –** Poor **Holding –** Poor	**Nursery –** Moderate **Spawning –** Good **Holding –** Excellent	**Nursery –** Excellent **Spawning –** Good **Holding –** Moderate
Section Substrata	% Bedrock:- 0 % Boulder:- 0 % Cobble:- 60 % Coarse Gravel:- 30 % Sand:- 5 % Silt:- 5	% Bedrock:- 0 % Boulder:- 40 % Cobble:- 10 % Coarse Gravel:- 10 % Medium Gravel:- 10 % Sand:- 20 % Silt:- 10	% Bedrock:- 0 % Boulder:- 40 % Cobble:- 15 % Coarse Gravel:- 20 % Medium Gravel:- 10 % Sand:- 10 % Silt:- 5	% Bedrock:- 0 % Boulder:- 5 % Cobble:- 40 % Coarse Gravel:- 15 % Medium Gravel:- 30 % Sand:- 10 % Silt:- 0
Section Dimensions	Section Length (m):- approx. 50 Section width (m):- 15 Mean Depth (m):- 1- 1.4 Bank Height(m):- 1m % Shading:- <10	Section Length (m):- approx. 50 Section width (m):- 10 Mean Depth (m):- 0.5- 2 Bank Height(m):- 4m % Shading:- <10	Section Length (m):- approx 60 Section width (m):- 10 Mean Depth (m):- 0.5- 2 Bank Height(m):- 4m % Shading:- <5	Section Length (m):- 20 Section width (m):- 15 Mean Depth (m):- 0.5- 1.2 Bank Height(m):- 1-2m % Shading:- <5
Flow Rate (m/s^{-1})	Imperceptible	0.22	0.22	0.22
Siltation Index	3 (moderate siltation)	3	3	3
Macrophyte % cover	*Caldophora spp*. – 50% Branched bur-reed - 5% Nuttall's pondweed - 5% *Ranunculus* spp. – 5% Fools Watercress – 1% Water Speedwell – 1% F Water Pepper – 1%	*Caldophora spp.* – 70% Broad Leave pondweed – 1% Branched bur-reed - 5% Nuttall's pondweed - 5% *Ranunculus* spp. – 5% Fools Watercress – 1% Water Speedwell – 1% Water Starwort – 1%	*Cladophora spp*. – 20% Branched bur-reed - 5% Nuttall's pondweed - 10% *Ranunculus* spp. – 5% Fools Watercress – 1% Water Speedwell – 1%	*Cladophora spp. – 10%* *Ranunculus* spp. – 40%

Mosses/liverworts/ bryophytes % cover	*Fontinalis spp. – 1%* O	*Fontinalis antipyretica – 1%*	*Fontinalis antipyretica – <2%*	*Fontinalis antipyretica – <2%* *Porella cordaena – 1%*

Table 3.1:- Habitat characteristics of the surveyed sites on the River Lee, September 2014

Characteristic	**Curraheen**			**Glasheen**
	Carrigrohane Bridge (site C1)	**Concrete Works (site C2)**	**GAA pitches (site C3)**	**Ashbrook (site G1)**
Section Profile	% Riffle:- 10 % Glide:- 60 % Pool:- 30	% Riffle:- 10 % Glide:- 70 % Pool:- 20	% Riffle:- 0 % Glide:- 90 % Pool:- 10	% Riffle:- 40 % Glide:- 50 % Pool:- 10
Salmonid habitat quality	Nursery - Moderate to poo Spawning – Good Holding - Excellent	Nursery - Moderate Spawning – Gooc Holding - Excellent	Nursery - Moderate Spawning – Poor Holding - Moderate	Nursery –Poor Spawning – Poor Holding - Poor
Section Substrata	% Bedrock:- 0 % Boulder:- 0 % Cobble:- 10 % Coarse gravel:- 30 % Medium gravel:- 30 % Fine gravel:- 10 % Sand:- 15 % Silt:- 5	%Bedrock:- 0 % Boulder:- 0 % Cobble:- 10 % Coarse Gravel:- 30 % Medium-fine Gravel:- 30 % Sand:- 10 % Silt:- 20	% Bedrock:- 0 % Boulder:- 0 % Cobble:- 0 % Coarse Gravel:- 20 % Medium-fine Gravel:- 30 % Sand:- 20 % Silt:- 30	% Bedrock:- 0 % Boulder:- 10 % Cobble:- 40 % Coarse gravel:- 30 % Medium-fine Gravel:- 10 % Sand:- 0 % Silt:- 10
Section Dimensions	Section Length (m):- 50 Section width (m):- 8 Mean Depth (m):- 0.7	Section Length (m):- 50 Section width (m):- 4 Mean Depth (m):- 0.6	Section Length (m):- 50 Section width (m):- 8 Mean Depth (m):- 0.9	Section Length (m):- 25 Section width (m):- 2 Mean Depth (m):- 0.3

Characteristic	Curraheen			Glasheen
	Carrigrohane Bridge (site C1)	**Concrete Works (site C2)**	**GAA pitches (site C3)**	**Ashbrook (site G1)**
	Bank Height(m):- 1m % Shading:- <5	Bank Height(m):- 1.5m % Shading:- <20	Bank Height(m):- 1.5m % Shading:- 10	Bank Height(m):- 3 % Shading:- 50
Flow Rate (m/s^{-1})	0.22	0.22	0.18	0.17
Siltation Index	3 (moderate)	3 (moderate)	4 (heavy)	4 (heavy)
Macrophyte % cover	Water Parsnip - <1% Common water Starwort - <1%	*Ranunculus* spp. – F *Cladophora* spp. – F Common water Starwort – O Canadian pondweed – O Fools Watercress – F Cladophora spp. - F	Unbranched bur-reed – 70% Common water Starwort – <5% Lesser Duckweed - <5%	None
Mosses/liverworts/ bryophytes % cover	*Fontanalis antipyretica – 1%*	*Fontanalis antipyretica – 1%*	*Fontanalis antipyretica – 1%*	None

Table 3.2:- Habitat characteristics of the surveyed sites on the Curraheen and Glasheen Rivers, September 2014

Characteristic	Bride			Glenamought
	u/s N20 culvert (site B1)	Commons Inn (site B2)	Orchard Court, Blackpool (site B3)	d/s Viaduct (site B4)
Section Profile	% Riffle:- 0 % Glide:- 100 % Pool:- 0	% Riffle:- 40 % Glide:- 50 % Pool:- 10	% Riffle:- 40 % Glide:- 40 % Pool:- 20	% Riffle:- 50 % Glide:- 40 % Pool:- 10
Salmonid habitat quality	Nursery –Poor Spawning – Poor Holding - Poor	Nursery - Moderate Spawning - Moderate (would be good if not silted) Holding – Poor	Nursery - moderate Spawning - Moderate Holding - Good	Nursery –Good Spawning - Moderate Holding - Good
Section Substrata	% Bedrock:- 0 % Boulder:- 0 % Cobble:- 0 % Coarse gravel:- 40 Fine gravel:- 20 % Sand:- 20 % Silt:- 40	% Bedrock:- 0 % Boulder:- 0 % Cobble:- 10 % Coarse gravel:- 60 % Sand:- 10 % Silt:- 20	% Bedrock:- 0 % Boulder:- 20 % Cobble:- 40 % Coarse gravel:- 20 % Sand:- 5 % Silt:- 15	% Bedrock:- 0 % Boulder:- 0 % Cobble:- 65 % Coarse gravel:- 20 % Medium gravel:- 5 % Sand:- 5 % Silt:- 5
Section Dimensions	Section Length (m):- 25 Section width (m):- 3 Mean Depth (m):- 0.3-0.4 Bank Height(m):- 1.5-2 % Shading:- <5	Section Length (m):- 25 Section width (m):- 3 Mean Depth (m):- 0.3-0.6 Bank Height(m):- 1-1.5 % Shading:- 50	Section Length (m):- 25 Section width (m):- 2-3 Mean Depth (m):- 0.3-0.4 Bank Height(m):- 1-2 % Shading:- 30	Section Length (m):- 25 Section width (m):- 2-3 Mean Depth (m):- 0.2-0.4 Bank Height(m):- 1-2 % Shading:- 30
Flow Rate (m/s^{-1})	0.13	0.13	0.18	0.13
Siltation Index	3 (moderate)	3-4 (mod to heavy)	3 (moderate)	3-4 (mod to heavy)
Macrophyte % cover	Fools Watercress – 90% Common Water starwort - <5%	*Cladophora* spp. – 10% Fools Watercress - <5% *Ranunculus* spp. - <1%	Fools Watercress - <5%	Fools Watercress - <5% *Cladophora* spp. - <10%

Characteristic	Bride			Glenamought
	u/s N20 culvert (site B1)	Commons Inn (site B2)	Orchard Court, Blackpool (site B3)	d/s Viaduct (site B4)
Mosses/liverworts/ bryophytes % cover		*Fontinalis antipyretica* - <1%	*Fontinalis antipyretica* - <2%	

Table 3.3:- Habitat characteristics of the surveyed sites on the Bride (North) and Glenamought Rivers, September 2014

Plate 3.1: River Lee – Lee Road (site L1)

Plate 3.2: River Lee – u/s County Hall Weir (site L2)

Plate 3.3: River Lee – d/s County Hall Weir (site L3)

Plate 3.4: River Lee – d/s Kingsley Hotel (site L4)

Plate 3.5: Curraheen River – Carrigrohane Bridge (site C1)	**Plate 3.6:** Curraheen River – Concrete Works (site C2)
	
Plate 3.7: Curraheen River – GAA pitches (site C3)	**Plate 3.8:** Glasheen River – Ashbrook (site G1)
	
Plate 3.9: River Bride – u/s N20 culvert (site B1)	**Plate 3.10:** River Bride – Commons Inn (site B2)
	
Plate 3.11: River Bride – Orchard Court (site B3)	**Plate 3.12:** Glenamought River – d/s Viaduct (site B4)

Table 3.4:- Photographic representation of the electro-fishing and dive-surveyed sites as part of the Lower Lee Flood Relief Scheme, September 2014.

Electro-fishing results

Electro-fishing surveys of the existing fish stocks in the Rivers Lee, Curraheen, Glasheen, Bride (North) and Glenamought were conducted over Saturday 27th to 30th September 2014, following notification to Inland Fisheries Ireland. The results of the surveys are discussed below in terms of fish population structure, and the suitability and value of each of the surveyed areas as nursery and spawning habitat for Annex II fish species.

River Lee – Lee Road (site L1)

A total of eight fish species were recorded in the surveyed section along the Lee Road, west of Cork City. A length-frequency plot for each species recorded is presented in Figure 3.1. Minnow (*Phoxinus phoxinus*), followed by Roach (*Rutilus rutilus*), Atlantic salmon and Brown trout, were the most frequently recorded species at the time of surveying. Gudgeon (*Gobio gobio*), Perch (*Perca fluviatilis*) and Stone loach (*Barbatula barbatula*) were also captured, along with a single example of European eel (*Anguilla anguilla*). Incidentally, the flow rate in the section at the time of the survey was imperceptible (due to unseasonably low rainfall throughout the region), which greatly reduced the effectiveness of the electro-fishing equipment.

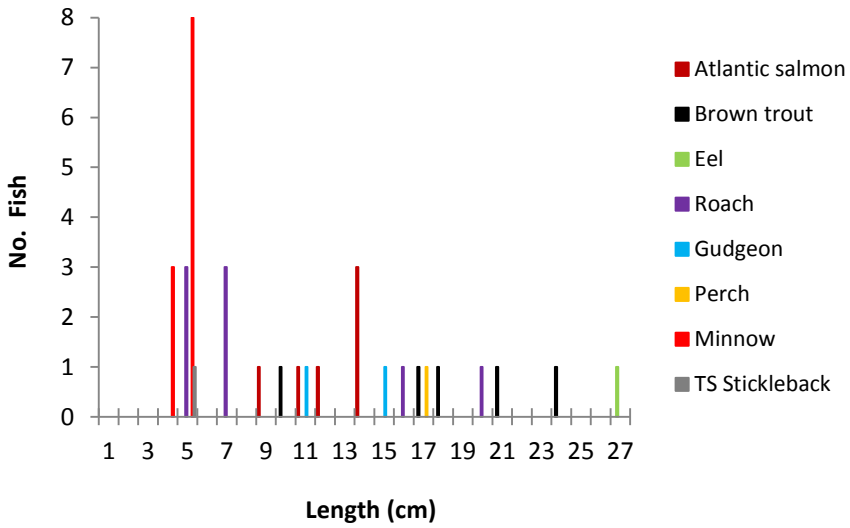

Fig 3.1:- Length-frequency distribution plot for all fish species recorded at River Lee – Lee Road (site L1) September 2014

River Lee – d/s Kingsley Hotel (site L4)

In contrast to the Lee Road site, the River Lee downstream of the County Hall Weir (at the Kingsley Hotel) features an increased flow regime even during periods of low rainfall given the drop in channel gradient from the nearby weir upstream. As such, the habitat is more suitable for salmonid species and was considered an excellent nursery for salmon. Very clean river gravels, in clear water adjoined beds of *Ranunculus* sp. vegetation providing excellent cover. In support of this, Atlantic salmon parr were the most abundant species recorded at this site (n=15). Low numbers of Brown trout, Eel, Perch and Stone loach were also present. As this site is located within the upper tidal reaches of the River Lee, several Flounder (*Platichthys flesus*) were unsurprisingly recorded. A length-frequency plot for each species recorded is presented in Figure 3.2 below.

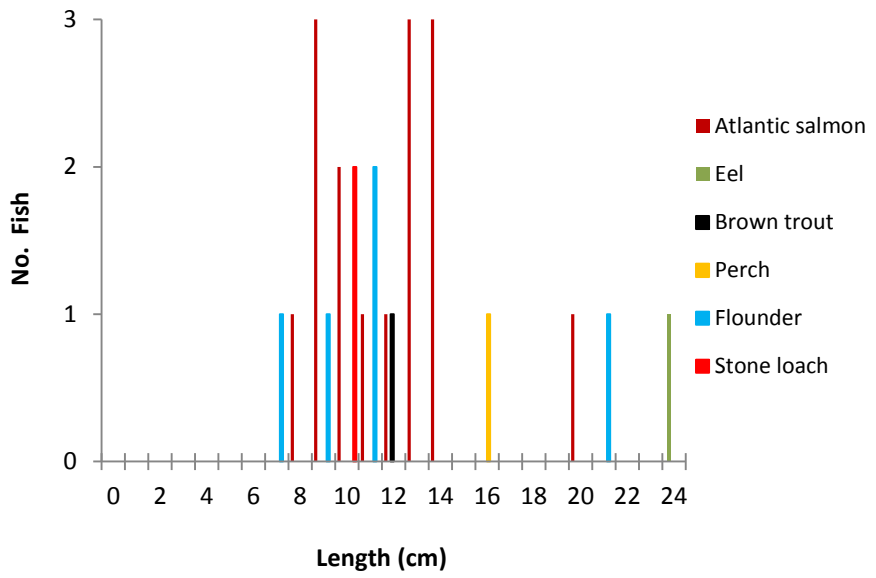

Fig 3.2:- Length-frequency distribution plot for all fish species recorded at River Lee – d/s Kingsley Hotel, Cork City (site L4) September 2014

Curraheen River – Carrigrohane Bridge (site C1)

A total of five fish species were recorded from the Curraheen River downstream of Carrigrohane Bridge. Brown trout were the most frequently recorded species (*n*=17). The average size was relatively large, owing to the good feeding and holding habitat present at this site. Annex II-listed River lamprey (*Lampetra fluviatilis*) transformers (*n*=5) were also identified at the site. Single examples of Atlantic salmon, flounder and eel were also captured. A length-frequency plot for each species recorded is presented in Figure 3.3 below.

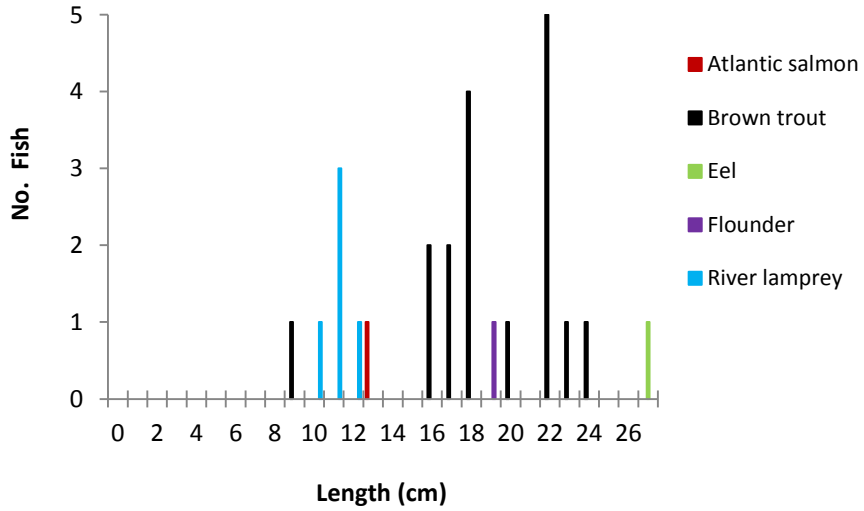

Fig 3.3:- Length-frequency distribution plot for all fish species recorded at Curraheen River – Carrigrohane Bridge (site C1) September 2014

Curraheen River – Concrete Works (site C2)

The species diversity in the second Curraheen River site was relatively high (8 species). The channel was an excellent nursery habitat for lamprey and an excellent ault trout habitat, given the incised banks and weed beds bordering gravel and sand/ silt shoals. At the Concrete Works site, Brook lamprey (*Lampetra planeri*) and Brown trout were the most abundant species present, with just a single River lamprey transformer recorded. Low numbers of Atlantic salmon, Flounder and Stone loach were present, and a number of 'yellow' European eel (>35cm SL) were also captured. A length-frequency plot for each species recorded is presented in Figure 3.4.

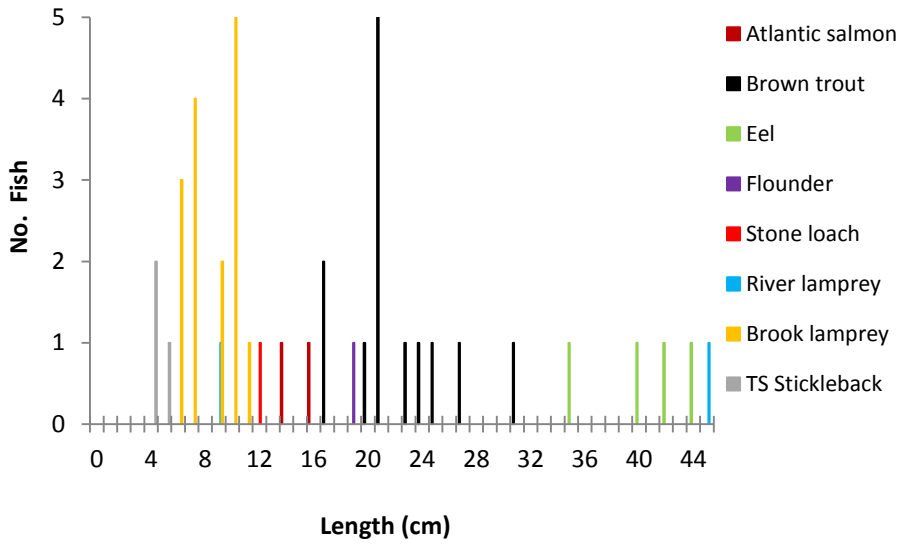

Fig 3.4:- Length-frequency distribution plot for all fish species recorded at Curraheen River – Concrete Works (site C2) September 2014

Curraheen River – GAA Pitch (site C3)

A total of five species were recorded from the Curraheen River near its confluence with the south channel of the River Lee, Cork City. Brown trout followed by Atlantic salmon were the most frequent species, despite a low flow, heavy siltation and a substantial cover of submerged macrophytes (i.e *Sparganium emersum*). Other species included stone loach along with single specimens of European eel and River lamprey (transformer). While the river was canalised and heavily silted it supported a healthy population of fish. A length-frequency plot for each species recorded is presented in Figure 3.5.

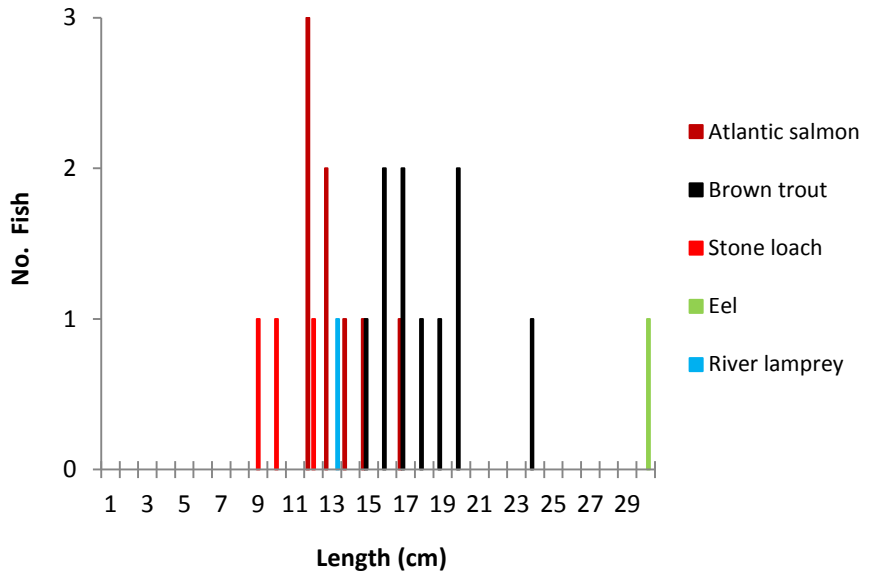

Fig 3.5:- Length-frequency distribution plot for all fish species recorded at Curraheen River – GAA pitches (site C3) September 2014

Glasheen River – Ashbrook (site G1)

The observed habitat and water quality at the single surveyed site on the Glasheen River was poor, with heavy siltation and heavy shading. This was reflected in the electro-fishing results, where European eel (*n*=4) was the only species captured. A length-frequency plot for the European eel recorded is presented in Figure 3.6. It is evident that salmonids have been extirpated from the habitat given the presence of point sources of pollution, riverbed siltationand visible historical channel alterations that have reduced the quality of the habitat.

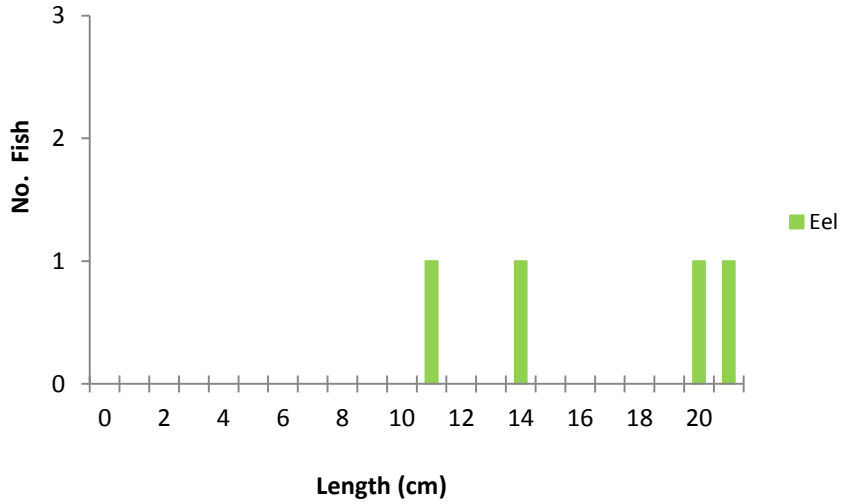

Fig 3.6:- Length-frequency distribution plot for all fish species recorded at Glasheen River – Ashbrook (site G1) September 2014

River Bride – u/s N20 culvert (site B1)

A low diversity and abundance of fish species was recorded from the River Bride site upstream of the N20 culvert (overpass), with River lamprey transformers (*n*=2) and single examples of Brown trout and European eel captured from a low-flow site choked with *Apium nodiflorum* (>90% cover). A length-frequency plot for each species recorded is presented in Figure 3.7

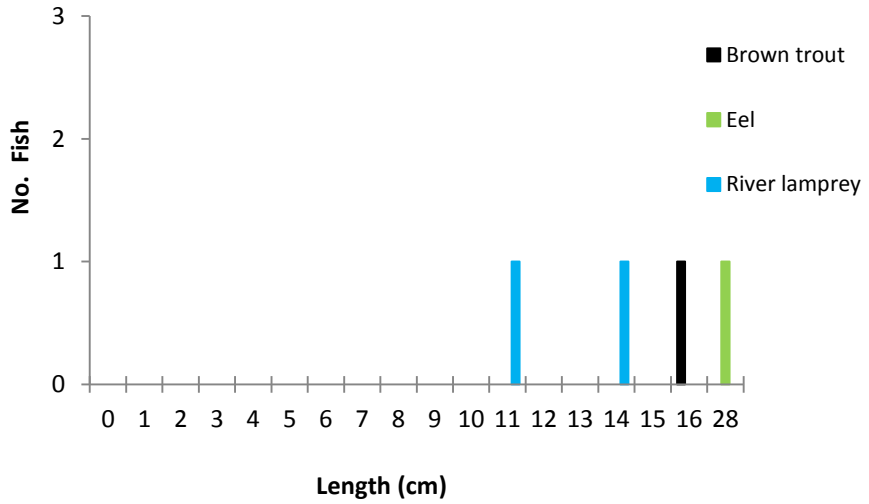

Fig 3.7:- Length-frequency distribution plot for all fish species recorded at River Bride – u/s N20 culvert (site B1) September 2014

River Bride – Commons Inn (site B2)

The River Bride on the Commons Road becomes increasingly encroached by industrial development. Howver it maintaians a semi-natural channel and the better quality water from upstream likely helps in maintaining some salmonid habitat. The River Bride site in the vicinity of the Commons Inn was found to hold a single species only, namely Brown trout (*n*=11). A length-frequency plot for the Brown trout recorded is presented in Figure 3.8.

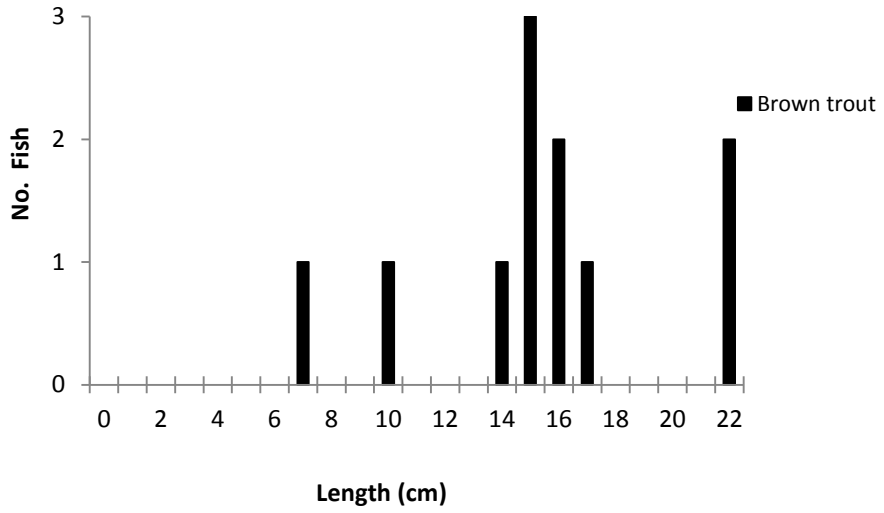

Fig 3.8:- Length-frequency distribution plot for all fish species recorded at River Bride Commons Inn (site B2) September 2014

River Bride – Orchard Court, Blackpool (site B3)

Similar to the other surveyed sites on the River Bride, the sampling site at Orchard Court, Blackpool contained a low fish diversity. In this area the Bride forms its last natural area of habitat before being heavily culverted in Blackpool. The river was bordered by deomestic housing flats and was encroached heavily by Japanese Knotweed. Brown trout were, again, the dominant species, although their abundance was relatively low (*n*=6). A single large European eel was also recorded. A length-frequency plot for both species recorded is presented in Figure 3.9

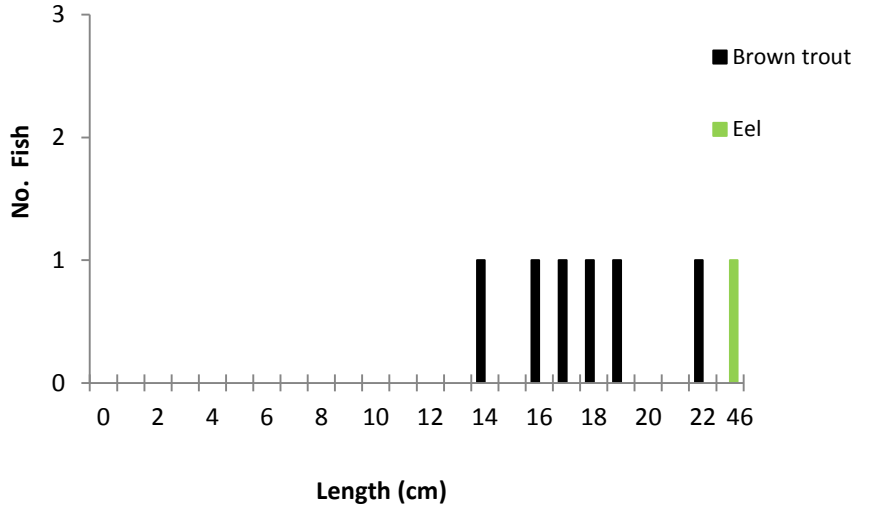

Fig 3.9:- Length-frequency distribution plot for all fish species recorded at River Bride – Orchard Court (site B3) September 2014

Glenamought River – d/s Viaduct (site GL1)

Two species were recorded from the single surveyed site on the Glenamought River, a tributary of the River Bride. The Glenamought is a very natural river channel and the wide river valley upstream with wet woodland and low intensities of housing has helped preserve the good quality habitat of the river. It may be considered the most pristine part of the River Bride catchment. Brown trout were abundant at the site (n=31) and a wide range of size classes was present in the section characterised by a clean cobble substrate, riffle/glide system and a relatively high flow rate. Two River lamprey transformers were also recorded, indicating suitable lamprey spawning habitat upstream of the site. A length-frequency plot for both species recorded is presented in Figure 3.10.

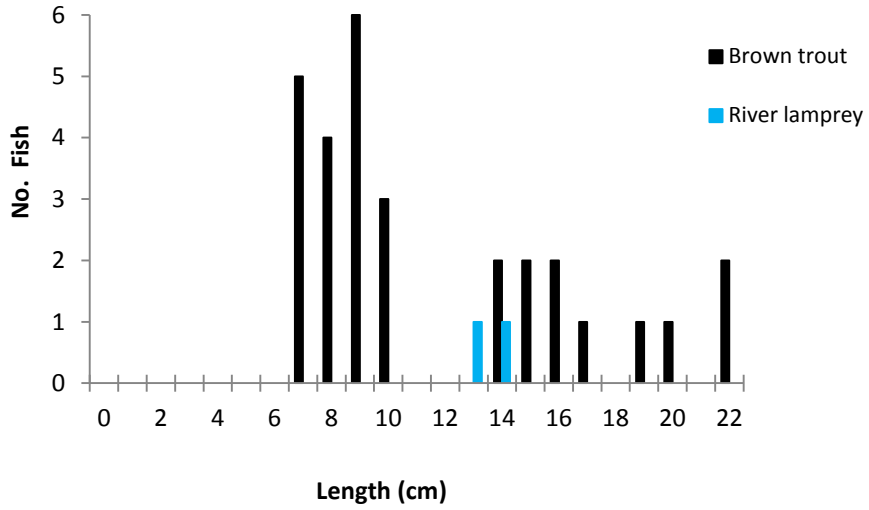

Fig 3.10:- Length-frequency distribution plot for all fish species recorded at Glenamought River – d/s Viaduct (site B4) September 2014

Plate 3.13: Atlantic salmon (*Salmo salar*) parr from River Lee – Lee Road

Plate 3.14: Brown trout (*Salmo trutta*) captured from Curraheen River

Plate 3.15: : River lamprey (*Lampetra fluviatilis*) transformer captured from River Bride

Plate 3.16: European eel (*Anguilla anguilla*) adult catptured from Glasheen River

Plate 3.17: Stone loach (*Barbatula barbatula*) captured from Curraheen River

Plate 3.18: Perch (*Perca fluviatilis*) captured from River Lee – Lee Road

	
Plate 3.19: Atlantic salmon shot taken during the dive survey at the County Hall Weir (site L3)	**Plate 3.20** *Cladophora spp.* & *Fontanalis antipyretica* vegetation on rocks underneath the County Hall Weir (site L3)

Table 3.5:- Photographic representation of the fish species captured during electro-fishing and dive-surveys as part of the Lower Lee Flood Relief Scheme, September 2014.

Dive Survey (River Lee)

River Lee – u/s County Hall Weir (Site L2)

The dive formed three transects covering the north bank, south bank and channel centre (each 50m in length) at two locations upstream and downstream of the county hall weir. The survey facilitated an assessment of these two deep sections of channel that are not possible to survey with conventional electro-fishing equipment. The findings of the dive survey are summarised in Table 3.6 below. The River Lee upstream of the Weir was artificially deep following the construction of the weir. This caused the channel upstream of the weir structure to be slower moving as far as the Hollymount area. The slower water has resulted in exuberant *Cladophora* spp. growth, which covered upt o 80% of the channel bed. Very high densities of Greater Pond snails (*Lymnaea stagnalis*) grazed on the large mats of vegetation creating an alien looking landscape below the surface. Fish appeared to be largely restricted to the margins of the river where cover existed. The centre of the channel only held small densities of Brown trout holding in the current. However, on the north bank downstream of the water intake for the water treatment plant, large patches of Nuttall's Pondweed (*Elodea nuttali*) adjoined beds of broad leaved pondweed (*Potamogeton natans*) which supported good numbers of very large adult roach (circa 0.5-0.75kgs). Two small 'jack pike' (2-3kg) were also observed resting in the weeds in the river margins. Underneath the beds of Nutall's Pondweed small shoals of Three-spined stickleback were present along with juvenile roach. The south bank of the River Lee had small densities of minnow shoaling on the boulder revetments underneath the water adjoining the Lee Fields walkway. One adult eel was also seen resting in a crevice.

River Lee – d/s County Hall Weir (Site L3)

The River Lee downstream of the County Hall Weir was an area of deep fast-flowing water with good quality spawning gravels and adult salmonid holding habitat. The north bank had slower flowing water with beds of silt and sand colonised by Nuttall's Pondweed. The bed profile slopes in gradient from the shallower water of the north bank to the deeper water of the south bank. The south bank of the channel downstream of the weir had fast flowing very deep water (circa. 4m) that extended as far downstream as the Kingsley

hotel where the water sallowed into glide habitat. The fast water adjoining the south bank retaining wall held two shoals of large adult Atlantic salmon (4-8kgs), resting prior to their migration upstream. Each shoal had between 10-15 salmon that moved in circles between the island and the weir shoots. No brown trout or other species were observed in this area.

Table 3.6: Summary data for fish composition and habitats encountered during the dive-surveys in the River Lee, September 2014.

Survey Area	Trasect 1 (North Bank)	Transect 2 (Centre Channel)	Transect 3 (South Bank)
Site L2 (upstream County Hall Weir)	**General Description:-** Area of channel in backwater of the River Lee directly upstream of the weir on the north bank. water depths in this slow area of the margin of the River Lee were between 1.5 and 3m deep with very thick vegetation growth (pondweeds, reeds and blanket weed). The substrate comprised sand, silt and patches of gravels. **Fish:-** Abundant adult roach were present in the reed beds with two small pike also observed. Shoals of small roach were present in beds of Nutal'ls Pondweed with abundant three-spined stickleback also present within these mats of vegetation.	**General Description:-**The centre of the River Lee upstream of the weir had a water depth of 2.5m and was dominated by substrata of gravels and boulder. The substrate was also heavily colonised by Cladophora vegetation (circa. 90% cover) with large numbers of Greater Pond snails (circa 100 per m2). **Fish:-** Very small numbers of trout holding station in the current were present but the channel was largely barren and devoid of fish.	**General Description:-** Shallow area of channel cira 1.5-2m deep bordering the Lee fields on the south bank. A large stone revetment of boulder adjoins the channel from the River Lee walkway. It grades into a zone of thick Cladophora that covers the broad majority of the centre part of the channel of the River Lee. **Fish:-** Abundant minnow in small shoals along the rocky embankment. One adult eel observed in crevice. No brown trout or other species recorded.
Site L3 (downstream County Hall Weir)	**General Description:** Shallow area of water adjoining turbine on the sorth bank of the River Lee downstream of the weir (circa. 1.5m deep). Large banks of sand had accumulated which supported beds of Nutall's Pondweed. **Fish:-** Within the pondweed small numbers of Three-spined stickleback were present. Interestingly no salmon were observed under the weir falls in this area but the water was much shallower (circa 1.5m) than other areas and slower water velocities were present.	**General Description:-** Area of water between the weir centre pass (fish pass) and the river island downstream. The substrate was of medium and coarse gravels covered with patches of *Cladophora* vegetation. **Fish:-** Small numbers of adult salmon were observed swimming near the island but no fish were seen along the weir apron. The salmon appeared to be 4kgs plus in weight range.	**General Description:-** Area of deep fast moving water (circa. 4m deep) in front of large wall where salmon anglers fish. The substrate was composed of large boulders near the wall that graded into a deeper river pool with a gravel and sand bottom. The water velocities were fast. **Fish:-** Two large shoals of adult salmon were seen present. Each shoal contained 10-15 fish. The fish appeared to be between 4kgs and 8kgs in size. No fish apart from salmon were observed.

4. Conclusions

Evaluation of Fisheries Habitat

River Lee

The River Lee was surveyed in areas between the Lee Fields at Hollymount and the Kingsley Hotel area. Somewhat unsurprisingly, the River Lee yielded the greatest diversity of fish species during the surveys, with eleven recorded in total through electro-fishing. Notably, good stocks of Atlantic salmon parr (electro-fishing) and migrating adults (dive survey) were recorded. The River Lee is an important salmon fishery and the presence of good numbers of juvenile salmon and adults is indicative of a healthy fish population. The entire River Lee channel supports Atlantic salmon and the most important fishery exists at Inniscarra Dam, where smolts are released from the hatchery at Carrigadrohid to help sustain the ESB managed fishery. The Shournach and west Bride River tributaries downstream of the dam still receive runs of wild adult salmon during the spring and late summer (per. obs.). Given that the river has a well preserved riparian corridor between the Carrigrohane Weir and Inniscarra Dam in addition to limited encroachment on the river, it retaind a very natural and swift flowing profile. The dive survey did however reveal that nutrient enrichment was a problem on the River Lee. Large mats of Cladophora blanket weed formed in the slower moving stretches where nutrients settled out of suspension and facilitated algal growth. This was accompanied by large densities of grazing pond snails. None the less despite evident elevations in nutrient levels, good numbers of salmonids remained present.

No lamprey species were recorded from the two electro-fishing sites or during the dive survey. However, this is likely reflective of the lack of suitability of the sites surveyed (lack of soft sediment for ammocoetes) as opposed to their absence in the river. The construction of Inniscarra Dam in 1956 imposed a significant barrier to upstream migration of lamprey (and eel and salmonids, incidentally) in the Lee system (Igoe *et al.*, 2004). However, both brook and river lamprey (*Lampetra* spp.) are known in the lower river below this barrier (Igoe *et al.*, 2004; Kelly *et al.*, 2008; 2010), as are sea lamprey which have been observed spawning below the Lee Fields Weir (R. Macklin, pers. obs). Indeed, lamprey ammocoetes (*Lampetra* spp.) were the most frequently recorded species (n=97) at the Lee Fields site during the most recent Water Framework Directive fisheries assessment (Kelly *et al.*, 2010).

Roach (*Rutilus rutilus*) are a relatively recent introduction to the Lee system (c. 2008; Brazier & Macklin, unpublished data) and juveniles were recorded at the Lee Fields site. Roach are considered an invasive fish species under articles 49 & 50 of the EU habitats Directive and the spread of this non-native species in the River Lee is cause for concern with regards to inter-specific competition with Brown trout and Atlantic salmon. Pike (*Esox lucius*) were not recorded during the surveys but are known to be present in the river downstream of Inniscarra Dam in low densities (B. Brazier, R. Macklin pers. obs.). Whether pike are present in adequate numbers to assist in control of the expanding roach population of the lower Lee remains to be seen.

Although the Lower Lee Flood Relief Scheme encompasses the river from Inniscarra Dam as far as Tivoli Docks, Cork City, it was not feasible to conduct electro-fishing or dive surveys in the estuarine habitat. The furthest downstream site was located in the vicinity of the Kingsley Hotel, where the Lee diverges into its North and South channels. However, numerous estuarine species are known from this point downstream to Tivoli Docks, including Flounder, Thick-lipped Grey mullet (*Chelon labrosus*), Plaice (*Pleuronectes platessa*), juvenile Pollock (*Pollachius pollachius*), juvenile Cod (*Gadus morhua*), Common Goby (*Pomatoschistus microps*), Sand Goby (*Pomatoschistus minutus*), Five-bearded rockling (*Ciliata mustela*), Fifteen-spined stickleback (*Spinachia spinachia*), Nilsson's Pipefish (*Syngnathus rostellatus*), Scad (*Trachurus trachurus*) and Sea trout

(*Salmo trutta trutta*) (Kelly *et al*., 2010b). Atlantic salmon, European eel and lamprey move through the estuarine reaches on route to spawning grounds upstream and are likely to occur in the estuarine parts of the river at different times throughout the year.

Curraheen River

As with the Lee, the overall species diversity was high in the Curraheen River sites surveyed. Atlantic salmon parr were recorded at all three sites, albeit in low numbers. Spawning potential for salmonids was good at the two uppermost sites, although siltation has degraded the river habitat overall in these terms. Despite this, recorded Brown trout numbers were high, owing to the often excellent holding habitat of the sites (i.e. plenty of deeper pools).

The Curraheen offers good nursery habitat for Annex II lamprey species. Lamprey ammocoetes, regardless of species, require soft sediment (>5-10cm) in which to burrow, be it mud, sand, silt, clay or a matrix of all types (Maitland, 2003). Typically, this substrate would demonstrate a high organic content, such as that present at site C2 (Concrete Works area). This site was heavily silted and offered excellent larval lamprey habitat, with a high number of Brook / River lamprey (*Lampetra spp.)* present. Brook lamprey typically spawn in areas of lesser depth and lower flow velocities than the larger river lamprey (Lasne *et al*., 2010), hence their particularly high occurrence at this site and not the others surveyed, which are more suited to river lamprey. River lamprey (*Lampetra fluviatilis*) transformers were present at all three sites, although densities were low.

No Sea lamprey (*Petromyzon marinus*) were recorded from the Curraheen River. Sea lamprey typically utilise similar (or even the same) spawning areas to Atlantic salmon, spawning in coarse gravel, pebbles and sand, where the diameter of the gravel can vary from 1–11cm, where the overlying water column has a depth of 40–60cm (Igoe *et al*., 2004) and in relatively strong currents of up to 1–2ms–1 (APEM, 2004). Therefore, it stands to reason that if Atlantic salmon can spawn in the Curraheen (confirmed by the presence of parr) then sea lamprey may also be present at other (unsurveyed) sites along the watercourse.

Glasheen River

The single site surveyed on the Glasheen River offered poor fisheries habitat and potential, featuring a low flow rate with heavy siltation and excessive macrophyte growth. The river is highly modified and urbanised and it is accepted locally that water quality is poor, largely due to urban run-off. These characteristics were reflected in the low diversity and abundance of fish recorded. In fact, only a low number (n=4) of European eel were captured. The siltation of gravel beds clearly inhibits the spawning of salmonid and Lamprey species at this site, and the river in general. The heavy siltation and noxious densities of macrophyte vegetation, such as Unbranched Bur-reed (*Sparganium emersum*) present at this site, and throughout much of this short river, warrants remediation.

River Bride (North)

The River Bride, flowing in a North-South direction into Cork City, has also been heavily modified and suffers from urban pollution. Despite this, Brown trout nursery and holding habitat quality was generally moderate to good, although spawning substrata has been degraded due to siltation.

The diversion of the river underground from Blackpool to its confluence with the North channel of the River Lee (at Popes Quay), presents a significant barrier to upstream fish migration. No structure to assist in fish migration or passing has been installed on the Bride. Indicative of this was the lack of Atlantic salmon recorded at the surveyed sites. However, a pair of River lamprey transformers was captured from the uppermost site, which was heavily choked with Fools watercress (*Apium nodiflorum*). Despite this, the substrate

at this site (and the un-fished section upstream, incidentally) consisted largely of fine gravels suitable for river lamprey spawning (Aronsuu & Virkkala, 2014; Rooney *et al*., 2013).

The occurrence of anadromous River lamprey in the River Bride is peculiar. It was suspected that, like Atlantic salmon, migrating lamprey species (i.e. river and sea) would also be unable to navigate up the Bride catchment (comprising the Bride, Glenamought and Glen rivers). However, as the Bride discharges at a single point to the River Lee, it can only be presumed that River lamprey (unlike Atlantic salmon) are able to bypass the Blackpool culvert, which, under normal flow conditions features a very shallow depth profile (mean 10-20cm; pers. obs.). This is well below the recommended depth within culverts for easy adult Atlantic salmon passage of ≥150mm (National Roads Authority, 2005). However, there appears to be no visible structural barriers to migration in the channel albeit not an ideal scenario for migratory fish.

In Ireland, River lamprey spawn between March and May, having entered freshwater in the late summer/early winter period (Kelly & King, 2001). Although River lamprey swimming ability is far weaker than that of Atlantic salmon, lamprey can utilise alternative methods, such as oral disc attachment to substrata, to migrate upstream. Even so, the incline of the river/stream bed must be low for River lamprey passage, as their climbing ability is noted as poor (Russon & Kemp, 2011). Their inherent morphology also allows lamprey to navigate shallower water depths than larger species. It is hypothesised that the occurrence of low numbers of River lamprey transformers in the River Bride, as recorded in September 2014, is a result of favourable conditions such as suitable flow rates and water levels during a previous migration season.

Glenamought River

The status of the Brown trout population in the Glenamought appears healthy, with a range of size (and likely, year) classes recorded. The habitat of the surveyed site provided good nursery and holding conditions. Incidentally, much of the rest of the river, which flows through more rural areas, also provides a similar environment (pers. obs.). Generally speaking, the Glenamought tributary offers better spawning opportunities for Brown trout and it is likely that it acts as a source for much of the Bride's trout stocks.

As with the Bride, two river lamprey transformers were also recorded at the surveyed site. The hydrology of the Glenamought means that any lamprey must access the river through the Bride. Therefore, the occurrence of maturing lamprey here is presumably as a result of favourable flow conditions on the Bride during a previous migration season, as outlined above.

Evaluation of Fisheries Importance

Salmonids

In summary, Brown trout were the most frequent species recorded throughout the rivers Lee, Curraheen, Bride (north) and Glenamought, as surveyed for the Lower Lee Flood Relief Scheme. Although afforded no legal protection, the presence of Brown trout even in small stream and river sites (such as the Curraheen, Bride and Glenamought) remains important in an overall biodiversity, conservation and management context, especially in terms of genetic value (Carlsson *et al*., 1999; Carlsson & Nielsen, 2000). Wild Brown trout in Ireland are considered to be genetically diverse with numerous strains (Taggart *et al*. 1981; Ferguson, 2006; Massa-Galluci *et al*., 2010) and thus are important for the wider conservation and management of the species in Europe. Additionally, any watercourses containing good salmonid habitat, where not located within a protected area (e.g. NHA) or Natura 2000 site, can be considered of at least higher value local ecological importance (National Roads Authority, 2009). Brown trout remain an important indicator of the ecological

status of stream health. As such the removal of Brown trout also has consequences for a stream meeting 'good status' under the Water Framework Directive (2000/60/EC).

Atlantic salmon parr were recorded from the Lee and Curraheen. High numbers of adults were also observed at Lee Fields Weir during the dive survey, awaiting suitable flow conditions to recommence their upstream migration. Both rivers provide suitable spawning and nursery habitat, even in the vicinity of Cork City. The Glasheen, an urban tributary of the Curraheen, is considered largely unsuitable for salmonids in general due to poor habitat and water quality. The Bride (North) and Glenamought (especially) are also considered suitable (though far from optimal) for Atlantic salmon but their presence here is precluded by the seemingly un-navigable underground Bride culvert for the species in Blackpool, Cork City.

Lamprey species

Although not recorded during these surveys, suitable Annex II lamprey habitat is present in the lower Lee, downstream of Inniscarra Dam (Kelly *et al.*, 2010). The Curraheen also provides good (yet localised) brook and river lamprey habitat. Somewhat surprisingly, river lamprey transformers were recorded from both the Bride and Glenamought. Whilst unrecorded in the Glasheen, the existence of *Lampetra* species cannot be discounted.

The greatest threats to Brook lamprey are the potential impacts of pollution and dredging (NPWS, 2013). The same can be said for River lamprey, with the addition of migration barriers. As lamprey spend much of their life cycle in sediments (as ammocoetes), changes in siltation patterns can significantly impact on their habitat. Removal of sediments and allied river engineering works can lead to a loss or removal of sediment that may already contain juvenile lamprey (King *et al.*, 2008). In light of the proposed works for the Lower Lee Flood Relief Scheme, which suggests the installation of flood prevention walls to alter and refocus hydrological characteristics of the surveyed channels, lamprey may be at risk of losing channel features required for their lifecycle, i.e. fine sediment deposits. In order for lamprey ammocoete habitats to form or be maintained, a channel must have a capacity to deposit fine sediment along its margins or into 'alcove' niches, frequently in the lee of some obstructing feature that is disturbing the flow. This must be taken into account on all channels prior to any work commencement on the surveyed channels. Should disturbance of lamprey habitat remain likely, the population should be removed to suitable habitat outside the impact zone in order to prevent direct impacts. Should significant volumes of sediment be generated from works on the riparian zone they may travel downstream and impact on spawning redds for Atlantic salmon. As such carefully planned mitigation must be ensured to preserve the fishery assets.

Other fish species

Notably, numbers of roach were officially recorded (via electro-fishing) in the Lower Lee for the first time during these surveys. This non-native species first appeared in the Inniscarra and Carrigadrohid reservoirs c. 2008 (Brazier & Macklin, unpublished data). The presence of juveniles confirms that suitable spawning conditions exist for roach in the Lower Lee. Although primarily a freshwater species, roach are able to tolerate moderate salinities (up to 15pmm for adults, Thiel *et al.*, 1995) and thus are, theoretically, able to traverse the Lee Fields Weir, into brackish water and navigate downstream (via the River Lee South channel) to the Curraheen and Glasheen rivers. Though no examples were recorded from these Lee tributaries during these surveys, there is a risk that the species will colonise these watercourses in the near future.

The spread of roach has both potential advantages and disadvantages for the existing ecology of the lower Lee system. The increase in potential prey resources may benefit indigenous predators such as Annex I kingfisher (*Alcedo atthis*) and Annex II otter (*Lutra lutra*) and European eel, whilst conversely the increased

inter-specific competition may negatively impact native Brown trout and Atlantic salmon populations. It is currently unclear if resident predators, including those above as well as pike and cormorant (*Phalacrocorax carbo*), will be effective in curbing the spread of roach in the lower Lee.

European eel

The critically endangered European eel (Freyhoff & Kottelat, 2010) are considered to be the most threatened fish species in Ireland in a recent red listed publication on Irish Fish (King *et al.*, 2011). The European eel has protective status under the European Eel Regulation EC No. 1100/2007 to facilitate the recovery of the eel stocks since the large decline in the 1980's.

The physical characteristics of the sites surveyed on the Lee and Curraheen, with ample marginal refugia such as macrophyte stands and submerged branches, make them well suited as Annex II European eel feeding/foraging habitat. Eel were also recorded on the Glasheen and Bride rivers, where suitable habitat is also present. The Glenamought, although representing more of an upland/eroding watercourse (FW1) for much of its length is also deemed as providing good eel habitat.

During the proposed works as part of the Lower Lee Flood Relief Scheme, mitigation must be employed to maintain as much refugia habitat (e.g. sunken branches, boulders) in the surveyed channels as possible. Overall the fisheries habitats, as surveyed for the Lower Lee Flood Relief Scheme, of the Rivers Lee, Curraheen, Bride (North) and Glenamought can all be considered of High Value Local Importance for trout speciess, eel and lamprey (Lampetra spp.), given the presence of all species and the presence of good spawning and nursery habitat, in addition to healthy mixed stock compositions. The River Lee may however be considered of National Importance for salmonids as it is a designated salmonid water on S.I. No. 293/1988 - European Communities (Quality of Salmonid Waters) Regulations, 1988. The Glasheen River can be considered of High Value Local Importance for European eel but not for other species.

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Appendix I

DCMNR License

CERTIFICATE OF AUTHORISATION UNDER SECTION 14 OF THE FISHERIES (CONSOLIDATION) ACT, 1959 AS SUBSTITUTED BY SECTION 4 OF THE FISHERIES (AMENDMENT) ACT, 1962.

The Minister for Communications, Energy and Natural Resources in exercise of the powers conferred on him by Section 14 of the Fisheries (Consolidation) Act, 1959 as substituted by Section 4 of the Fisheries (Amendment) Act, 1962 hereby authorises:

Lisa Dolan, Ryan Hanley Environmental Consultants and or person(s) nominated by her to undertake an electro fishing survey for lamprey species on the River Shannon. Approximate locations of these sites (not to scale) are shown on attached map. The survey is to be included in an Environmental Impact Statement (EIS) an Appropriate Assessment (AA)/Natura Impact Statement (NIS) and hydrological impact assessment for the construction and ongoing impact of an instream hydro electricity facility

This authorisation is granted subject to the following conditions:

1. **This authorisation shall not confer on the holder thereof, independently of the conditions therein;**

   (a) **any rights or title which the holder would not have had if this Authorisation had not been given, or;**

   (b) **any authority in any way to interfere with or infringe the lawful rights of any other person.**

2. **This authorisation is issued to and valid for use by Lisa Dolan and or person(s) nominated by her.**

3. **This authorisation is valid from 11 September 2014 to 30 September 2014**

1

4. **The electro-fishing must be carried out only by nominated personnel with training and experience in such operations. Ryan Hanley Consulting Engineers shall submit the names of all such personnel including details of their training and experience**

5. **The electric fishing operation must be carried out during suitable weather and flow conditions. IFI recommend that electric fishing should be carried out between early July and 30 September when juvenile fish are of a sufficiently large size to be caught by electic fishing, to minimize damage to the fish and to be distinguished from similar species (CEN, 2001 and CFB "Electric Fishing in Wadeable reaches "manual).**

6. **Sampling should commence at the uppermost site on the river and finish at the lowermost site on the river to limit any possible upstream transfer of invasive species.**

7. **The consent of the fishery owner, and informs local angling clubs of their plans for the surveys where relevant. The applicant must also seek permission from landowners to cross land where relevant.**

8. **All electric fishing equipment must be available for inspection by an IFI officer during each survey.**

9. **IFI Limerick should be notified at least five working days in advance of the proposed commencement date of the electric fishing operation, by email to Amanda.Mooney@Fisheriedireland.ie / Catherine.Kerins@Fisheriesireland.ie**

10. **Any fish captured shall be carefully handled and returned alive to the water from which they are taken, following the gathering of data. The IFI is to be immediately informed of any fish mortalities. Details including the County, Site Number, River Name, Townland, Irish Grid Reference, species and numbers killed shall be communicated to the relevant IFI office by telephone to; IFI Limerick (061) 300238 for the attention of Catherine Kerins.**

11. Any and all of the electro fishing gear/equipment, including the transformer, generator nets etc shall be disinfected prior to and after use at each electro fishing site to prevent the spread of pathogens, disease, parasites or exotic species and to avoid the transfer of species such as anguillicola, zebra mussels and various plants etc. The holder of this authorisation shall strictly comply with the submitted Biosecurity measures and as directed by an officer of IFI Limerick.

12. When doing anything pursuant to this authorisation, the holder shall, if requested by any person affected, produce this authorisation to that person.

13. The survey report including the survey quantitative data obtained in the appraisal shall be forwarded electronically in the standard IFI format to Sandra Doyle, Inland Fisheries Ireland, 3044 Lake Drive, Citywest Business Campus, Dublin 24 , Sandra.doyle@fisheriesireland.ie within 30 days of completion of the survey. For ease of reference an electronic copy of IFI's standard template will be forwarded directly to the applicant.

14. The holder of this authorisation is competent in the use of electro-fishing gear. All equipment should be disinfected prior to and after use to prevent the spread of disease, parasites or invasive species and must strictly comply with IFI's Biosecurity measure (http://www.fisheriesireland.ie/Invasive-Species/ biosecurity-protocol-for-field-survey-work.html) and as directed by an officer of IFI Limerick.

15. Failure to comply with any of the conditions of this authorisation may result in revocation of this authorisation.

16. The holder of this authorisation should be mindful of the potential occurrence of invasive alien species, either in the wetted channels being surveyed or in the adjoining riparian zone. IFI would be grateful if the presence of such species could be recorded along with geo-reference and indication of the extent of occurrence and submitted in report form directly to IFI.

17. **The holder of this authorisation shall indemnify and keep indemnified the State, the Minister for Communications, Energy and Natural Resources and the Minister for Finance against any claims, arising in any manner whatsoever in connection with the user of the fishing gear or in the exercise of the permission hereby granted.**

18. **Notwithstanding the foregoing, this authorisation may be revoked or amended by the Minister for Communications, Energy and Natural Resources without the payment of compensation to the holder on giving one weeks notice in writing to the holder if he considers it necessary in the public interest to do so.**

Dated this 11 September 2014

For the Minister for Communications, Energy and Natural Resources.

Gerry Clerkin
An officer authorised on that behalf by the said Minister

Appendix 5C
River Lee Invasive Plant Survey

OFFICE OF PUBLIC WORKS

LOWER LEE FLOOD RELIEF SCHEME

INVASIVE PLANT SPECIES SURVEY

May 2015

RYAN HANLEY
CONSULTING ENGINEERS
Sherwood House, Sherwood Avenue, Taylor's Hill, Galway
170 Ivy Exchange, Granby Place, Parnell Square West, Dublin 1

Report Control Sheet

CLIENT	Office of Public Works
PROJECT NO	2365
PROJECT TITLE	Lower Lee Flood Relief Scheme
REPORT TITLE	Lowe River Lee Invasive Plant Survey

REV.	STATUS	AUTHOR(S)	REVIEWED BY	APPROVED BY	ISSUE DATE
0	Issued to Client	Ross Macklin, Bill Brazier, Thomas Kavanagh,	Jonathan Reid, Lisa Dolan, Sarah Mullen	Michael Joyce	25/06/15

Table of Contents

1. Introduction

Triturus Environmental consultants were appointed by Ryan Hanley to undertake an invasive plant survey along the corridor of the Lower River Lee and major tributaries (namely the Curragheen, Glasheen, Bride [North] and Glenamought) in Co. Cork (see Fig 2.1). The work was commissioned in order to establish the distribution of invasive plants overlapping proposed infrastructural flood relief works forming part of the Lower Lee Flood Relief Scheme. The scheme is required to prevent or minimise flood events damaging urban infrastructure. Severe flood events have become increasingly frequent in Cork City, the most significant being those occurring in November and December 2009.

The River Lee (river code: IE_SW_19_1663) runs for some 65km, with the catchment draining an area of approx. 1250km^2. According to O' Mahony (2009) the flora of the River Lee is 'varied and interesting, containing a range of wetland habitats and a wide mix of native and naturalised plants'. Given that the Lee has an important botanical diversity it is important to prevent the spread of invasive plants. This can be first achieved by identifying their distribution and then by removing them from affected areas.

Prior to the walkover survey component of this report, a number of terrestrial invasive species were identified from the survey area (NBDC, 2014), notably Himalayan Balsam (*Impatiens glandulifera*), Japanese Knotweed (*Fallopia japonica*) and Giant rhubarb (*Gunnera tinctoria*). Water fern (*Azolla filiculoides*) and Nuttall's Pondweed (*Elodea nuttallii*) are the two notable aquatic invasive species on the River Lee, both of which have been expanding their distribution more recently (pers. obs.).

Other non-native species which are considered less invasive included Buddleia (*Buddleia davidii*), Winter Heliotrope (*Petasites fragrans*), Snowberry (*Symphoricarpos albus*), Cherry Laurel (*Prunus laurocerasus*) and Montbretia (*Monbretia x crocosmiiflora*). Additionally, O' Mahony (2009) also records Travellers Joy (*Clematis vitalba*) and Prickly lettuce (*Lactuca serriola*) as alien threats to the lower Lee. The former is very widespread in the urban hedgerows of Cork City (pers. obs.). None of these species were appraised during the current survey as they are not considered noxious invasive threats.

The primary purpose of this report was therefore to record noxious invasive plant species in order to identify the extent of overlap between them and the proposed flood relief works areas. The noxious invasive species are those which have the greatest risk of reducing riparian diversity, damaging ecosystem functioning or damaging infrastructure (e.g. Japanese Knotweed). On the River Lee the most prominent noxious invasive plants would include Himalayan Balsam, Japanese Knotweed and Giant rhubarb. By identifying where invasive plants overlap with works areas, mitigation can be recommended to prevent their spread due to mechanical disturbance or transfer to other areas off-site by machinery.

In addition to collation of field records, this report provides a contemporary baseline GIS database of noxious invasive species along the River Lee and tributaries Curragheen, Bride and Glenamought river corridors. The records of these species will assist their future management and help inform strategies for control over time by interpolating changes in patterns of spread.

Invasive species

An invasive species can be defined as one who's introduction and/or spread outside their natural past or present distribution threatens biological diversity (Convention on Biological Diversity). A wider definition includes the characteristic of causing economic or environmental detriment or harm to human health. The damage to native species and ecosystems worldwide caused by invasive non-native species is estimated to be as serious as the loss and degradation of habitats (IUCN, 2000).

Aside from environmental impacts, the economic costs associated with the control and management of invasive species are also cause for serious concern. Invasive species can, and do, negatively affect many sectors including tourism, recreation, agriculture, horticulture and construction. In Ireland alone the most recent estimate of economic impact caused by invasive species stands at over €202 million annually (Kelly *et al.*, 2013).

Notably, not all non-native (alien) species have the potential to become invasive (Richardson *et al.*, 2000) and their potential threat is determined by a number of inter-related factors (Williamson & Fitter, 1996; Stokes *et al.*, 2006). For a species to become invasive it must successfully out-compete native organisms, spread through its new environment, increase in population density and harm ecosystems in its introduced range (Keller *et al.*, 2011).

Incidentally, for the purposes of this report, it should be clarified that a non-native species does not automatically convey invasive properties. Whilst many species in Ireland, such as sycamore (*Acer psuedoplanatus*), beech (*Fagus sylvatica*) and fuschia (*Fuschia magellanica*) are indeed (established) non-native, their overall ecological impact on biodiversity is considered low or benign (Stout, 2011; O Flynn *et al.*, 2014). In fact, a recent estimate is that only 19% of non-native plants with well-established populations are considered invasive in Ireland (Milbau & Stout, 2008). Certain non-native plant species, such as Buddleia and Montbretia are typically only recorded on a local scale and have not been shown to have any wide reaching negative implications on biodiversity in Ireland. Nevertheless, whilst some non-native species may have little impact on a national scale they can be associated with severe impacts on a local scale and should not be ignored (Milbau & Stout, 2008).

Therefore, the focus of this report is to assess those non-native plants which are deemed noxious invasive species. In accordance with both the Draft Cork County Development Plan 2013 and the Cork City Development Plan 2015-2021, the principal invasive species within the study area are considered to be Japanese Knotweed and Himalayan Balsam. Others terrestrial invasive species such as Giant Rhubarb were also surveyed for. Nuttall's Pondweed and *Azolla* Water fern were also surveyed for in aquatic habitats (i.e. river channels).

Invasive species legislation in Ireland

Invasive species present a serious threat to native biodiversity and failure to address the issues of non-native or invasive species may contravene Ireland's obligations under a number of conventions and the EU Habitats Directive (NRA, 2010). For example, among the worst invasive plants in Ireland are Japanese and Giant Knotweed (*Fallopia sachalinensis*), which are now listed under the 3rd Schedule: Part 1 of Birds and Habitats Directive S.I 477 of 2011 as non-native (plant) species subject to restrictions under Regulations 49 & 50. Regulation 49 deals with the "Prohibition on introduction and dispersal" of listed species such as Japanese knotweed; while Regulation 24 seeks to "to prevent the dispersal, establishment or spread of an animal or plant to which Regulation 49 or 50 applies". Additionally, the Wildlife (Amendment) Act 1976 - 2000 states that "anyone who plants or otherwise causes to grow in a wild state in any place in the State any species of (exotic) flora, or the flowers, roots, seeds or spores of (exotic) flora shall be guilty of an offence".

2. Methods

Desktop review

Prior to field survey commencement, an in depth review of literature relating to invasive species and any previous ecological studies of the study areas were carried out. Relevant published and un-published reports and literature were consulted.

Study Sites

The survey focused on the defined proposed works areas as opposed to the entire length of river channels. Works areas were present along the Lee (both North and South channels), Curragheen, Bride (North) and Glenamought river's.

For survey purposes the proposed discrete works areas were broadly grouped according to seven geographic locations, i.e. Inniscarra, Lee Fields, Curragheen, Wellington Bridge, Lee North channel, Lee South Channel and Blackpool; Fig 2.1). This facilitated more efficient mapping of the discrete works area zones. The assessment of the distribution of invasive plants within the proposed works zones incorporated the rivers listed in Table 2.1 below and as illustrated in Figure 2.1.

Table 2.1: River channels surveyed for invasive species as part of the Lower Lee Flood Relief scheme

River	Survey area	Length of channel to be surveyed (approx.)
River Lee (lower)	Iniscarra Hydroelectric Dam d/s to Tivoli Docks, Cork City (including both the North and South channels of the river flowing through Cork City & the secondary channel flowing through Ballincollig Park)	25.3km
Curragheen River	150m u/s Carrigrohane Bridge, d/s to confluence with River Lee South channel	3km
Glasheen River	R608 road bridge (Glasheen) d/s to confluence with Curragheen River	0.5km
River Bride (North)	150m u/s Blackstone Bridge d/s to Blackpool, Cork City (where river is culverted underground until River Lee confluence)	3.4km
Glenamought River	300m u/s Kilcully Bridge d/s to confluence with River Bride at North Point Business Park	0.57km

Mapping Invasives

A key objective of the project was to store and manage all invasive species data recorded during the field surveys on a GIS database, for ease of dissemination and assimilation between relevant stakeholders and authorities. The GIS database was constructed using a combination of MS Excel 2010 and the open-source Quantum GIS v2.4. At the commencement of the field survey period a joint training day with all surveyors was undertaken to ensure consistency of field procedures and data recording. Features of interest were recorded in the field using a GLONASS-supported Garmin eTrex 30 handheld GPS unit. Each individual feature of interest (i.e. invasive and non-native species) was assigned a unique identifier code for each of the five rivers surveyed, as well as each defined proposed works area. This

information included species name (common and scientific), GPS coordinates (ITM), surrounding habitat type and land use, details on physical attributes (such as dimensions of stand, other species associations) and details on the location of the feature within the site. Additionally, this information was correlated, through the same unique identifier code, to individual photographic images, as well as annotated maps. Invasive species were mapped within a 50m buffer of the river channels. Any further distance from the channels was considered outside the zone of influence of any proposed works. Three individual datasets were constructed, with invasive species recorded and annotated as either a polygon (≥100m^2 in area), polyline (≥10m in length and ≤2m in width) or a single point (≥1m in are / length or ≤100m^2).

The survey concentrated on the riparian zone either side of the main watercourses, however systematic checks were also carried out of the aquatic zone to determine the presence of aquatic invasive species, such as Nuttall's Pondweed (*Elodea nuttalii*).

Figure: 2.1 Overview of the Lower Lee Flood Relief Scheme study area illustrating the seven geographical zones containing proposed works areas

Optimum Survey Period

Walkover surveys for invasive species were carried out during optimum periods when plants were still vegetated and/or in flower. In practice this was the August to September period, prior to the autumn die-back. This timing was vital and aided in correct species identification and also facilitated a more accurate appraisal of the true density and distribution of invasive plant species along the River Lee and selected tributaries. Aquatic species surveys were also conducted during this period where good water clarity allowed.

3. Results

General overview

Field work was undertaken during August and September 2014. A total of 88 individual records of invasive species were documented during the course of the study, within the proposed works areas on five rivers (Lee, Curragheen, Bride [North], Glasheen & Glenamought). Summary data of each individual record is presented in Appendix 1. Maps showing the distribution of records for each river channel are outlined in the following sections.

Overall, the most commonly recorded species was Japanese Knotweed, being observed at 51 locations within the proposed works areas. This was followed by Himalayan Balsam, which was recorded in 21 separate locations. Broadly speaking, Himalayan Balsam was most frequent along the River Lee, particularly in the sections from Lee Road downstream to Fitzgerald's Park (Cork City). Japanese Knotweed was especially frequent within Cork City boundaries, on the Lee, Curragheen and Bride (North) rivers. Notably, none was recorded downstream of Clarkes Bridge, Cork City centre. However, the Mardyke walkway (i.e. UCC North Mall Campus) had very dense stands of knotweed behind areas enclosed by fencing.

Fig 3.1:- Himalayan Balsam growing in shade along the Lee Fields, River Lee (North bank)

A new invasive species record for the survey area (according to the data of O Mahony (2010); NBDC, 2014), for Nuttall's Pondweed (River Lee) was documented. Nuttall's Pondweed was especially prominent in the Lee Fields stretch of the River Lee. These records are detailed in Appendix I. The findings for each river surveyed are presented below in specific relation to overlaps with proposed works area boundaries.

River Lee - invasive species overlaps with proposed works areas

Within the works areas along the River Lee (both north and south channels), a total of 5 noxious invasive plant species were recorded (three terrestrial, two aquatic)[1]. Japanese Knotweed was the most frequently recorded invasive, occurring at 30 different locations within the works areas. This species was particularly abundant within the Cork City boundaries. Himalayan Balsam was recorded at 21 locations along the River Lee works areas. Giant rhubarb was locally frequent in Fitzgerald's Park and on the north bank of the River Lee opposite the park. Nuttall's Pondweed, a submerged aquatic macrophyte previously unrecorded downstream of Inniscarra Reservoir (Caffrey *et al.*, 2006), was recorded at 8 locations. It was widespread on the north bank on the River Lee in the Lee Fields in slack areas of water. Its distribution was localised and no extensive stands were observed. The water fern, *Azolla filiculoides* was recorded at a single small, wetland location at Hollymount, on the north bank of the Lee Fields. No other aquatic invasive species were recorded. The overall distribution of invasive species along the lower River Lee proposed works areas are shown in Figures 3.2a, 3.2b, 3.2c, 3.2d and 3.2e.

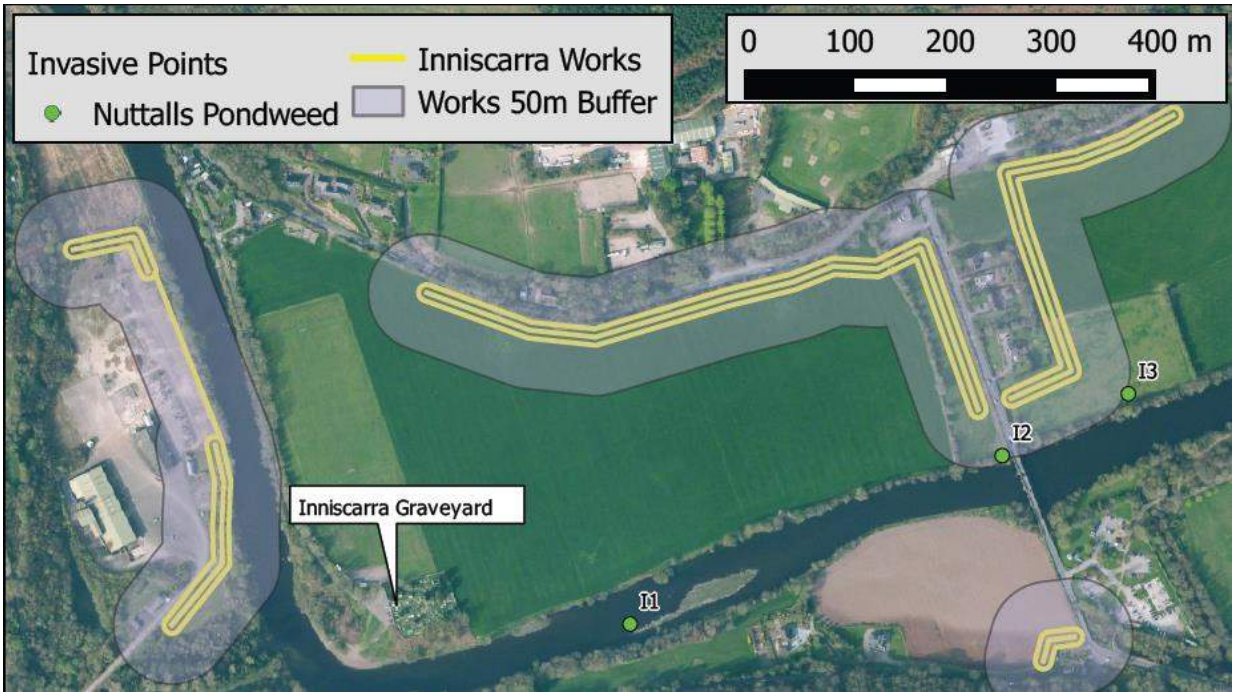

Fig 3.2a:- Map showing invasive species recorded within the proposed works areas along the River Lee (Inniscarra area). Further details are provided in Appendix I.

[1] This report will be revised on confirmation of the extent of the proposed flood relief scheme.

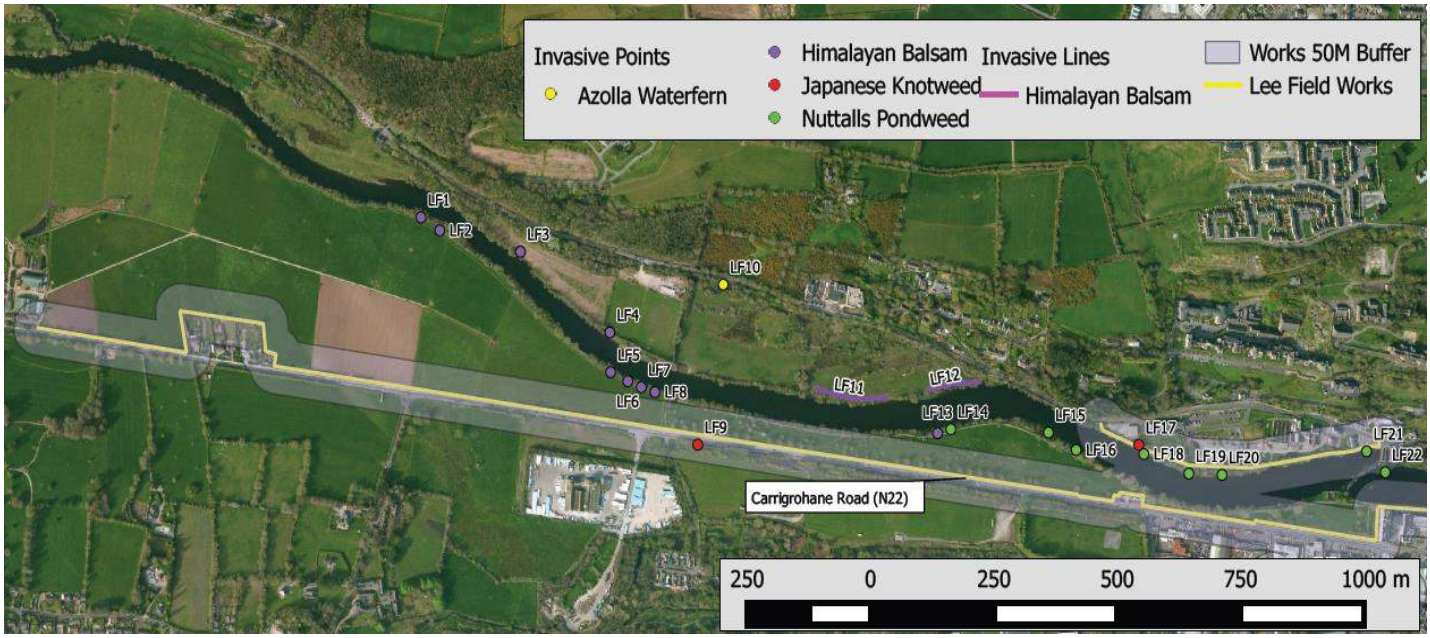

Fig 3.2b:- Map showing invasive species recorded within the proposed works areas along the River Lee (Lee Fields area). Further details are provided in Appendix I

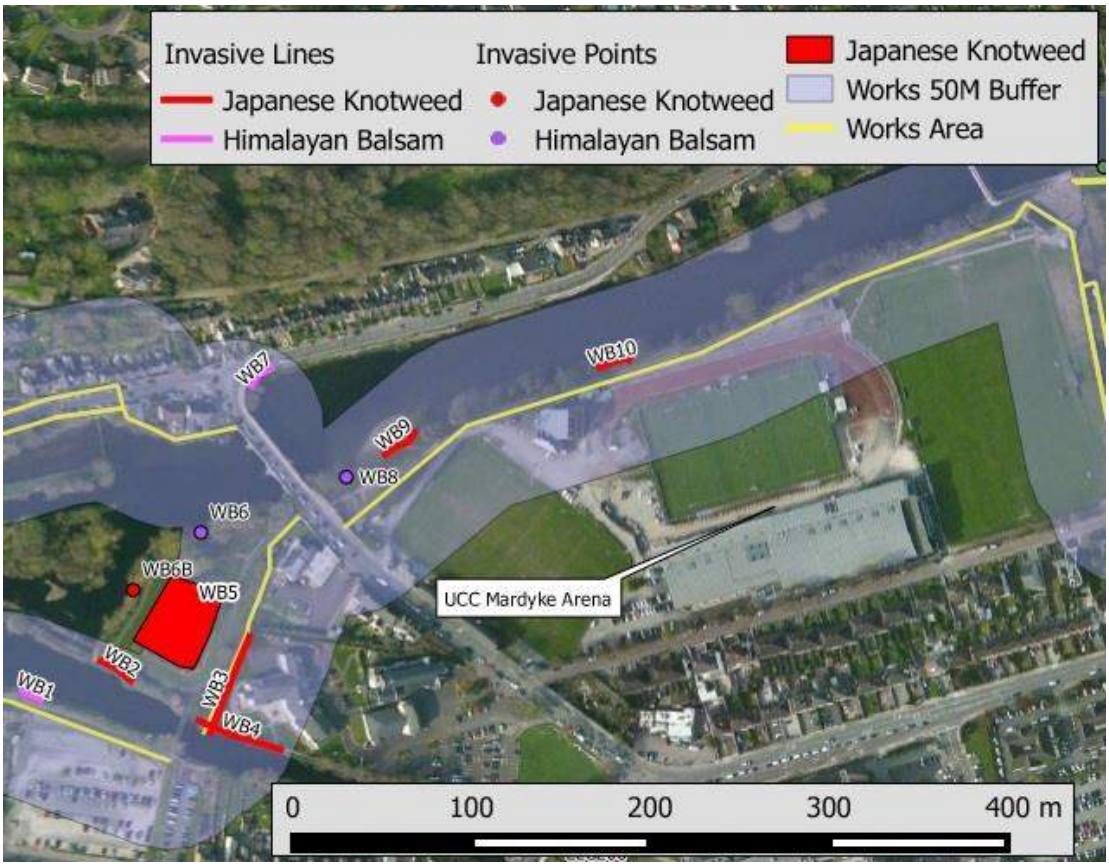

Fig 3.2c:- Map showing invasive species recorded within the proposed works areas along the River Lee (Wellington Bridge area). Further details are provided in Appendix I

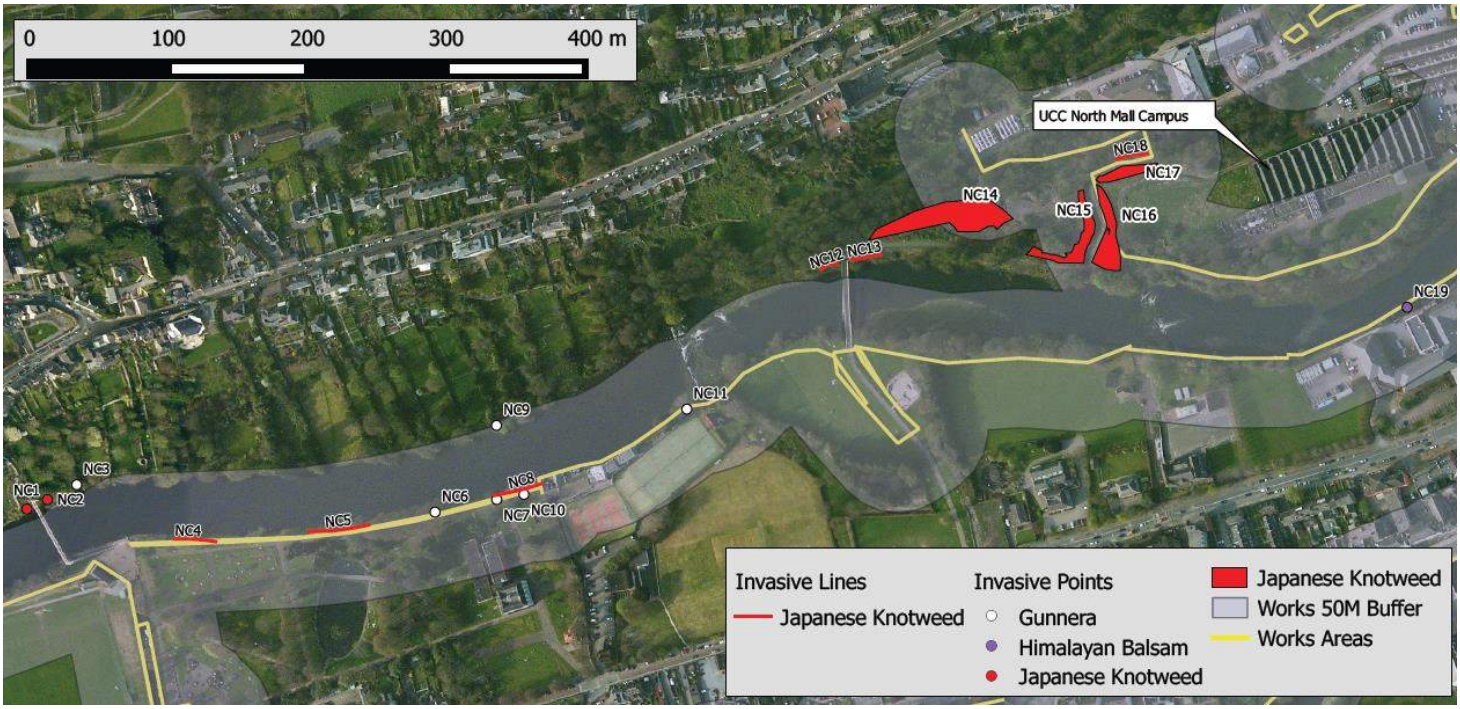

Fig 3.2d:- Map showing invasive species recorded within the proposed works areas along the River Lee (UCC North Mall Campus area). Further details are provided in Appendix I

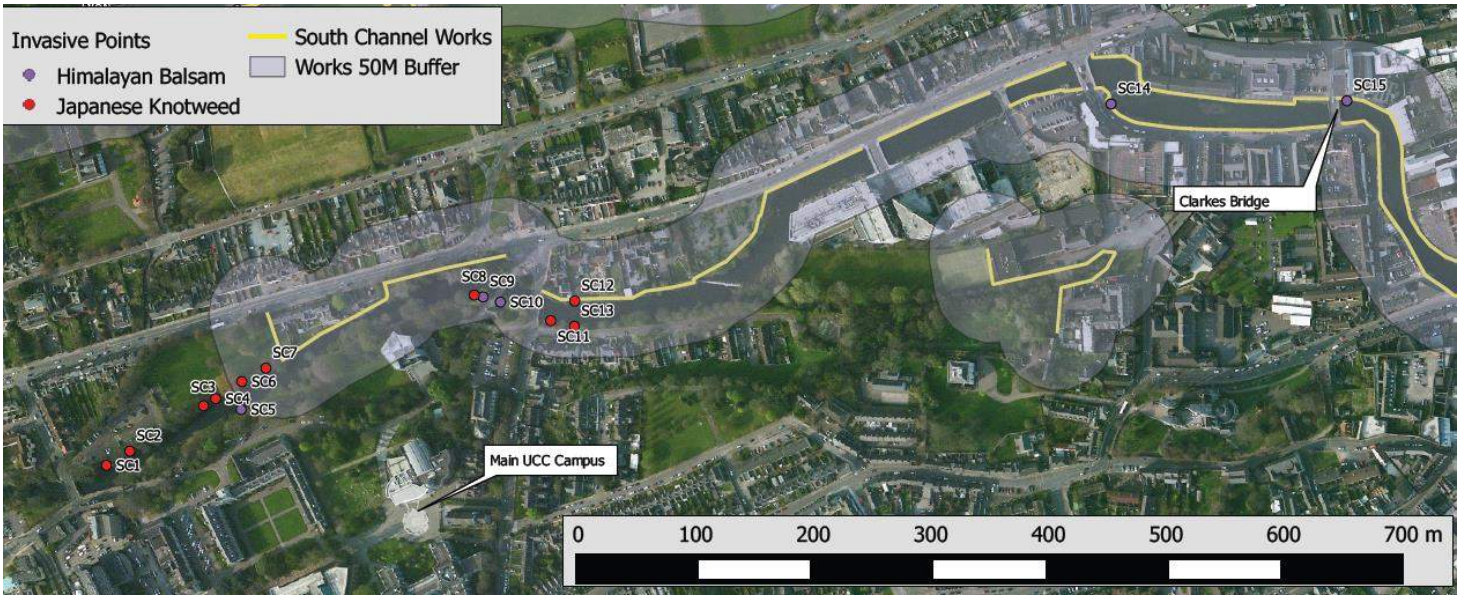

Fig 3.2e:- Map showing invasive species recorded within the proposed works areas along the River Lee (South Channel area). Further details are provided in Appendix I

Curragheen River - invasive species overlaps with proposed works areas

One invasive plant species was recorded along the works areas on the north and south banks of the Curragheen River – namely Japanese Knotweed. The species occurred at 6 locations within these areas (five points and one linear strip). No aquatic invasive species were recorded along the Curragheen. The distribution of invasive species along the Curragheen River is shown in Fig 3.3.

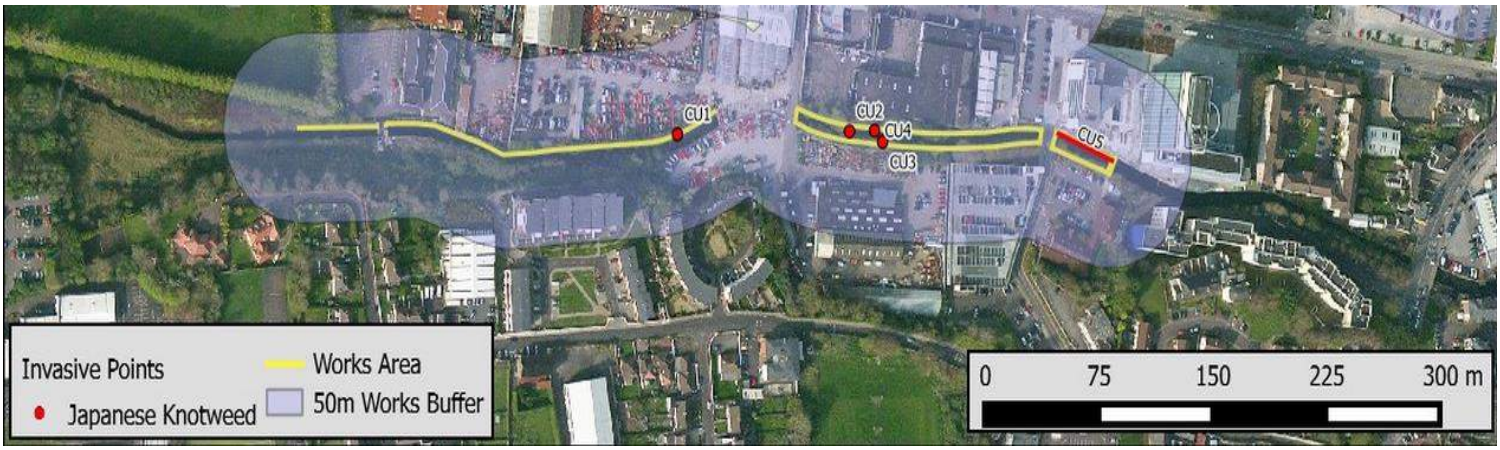

Fig 3.3:- Map showing invasive species recorded with the proposed works areas along the Curragheen River, Cork City. Further details are provided in Appendix I

River Bride-invasive species overlaps with proposed works area

Two invasive species, Japanese Knotweed and Giant rhubarb, were recorded along the proposed works areas on the River Bride channel. All told, Japanese Knotweed was recorded at 12 locations within these areas, whilst Giant rhubarb was present as a single plant in the amenity park adjacent to Blackpool Retail Park. No aquatic invasive species were recorded in the River Bride. It should be noted that approx. 1.5km of the channel is culverted underground from Blackpool, Cork City to its confluence with the River Lee at Popes Quay and thus it was not possible or pertinent to survey this section. The distribution of invasive species along the River Bride is shown in Fig 3.5.

Fig 3.4:- Japanese Knotweed on the River Bride at Orchard Court, Blackpool, Cork City

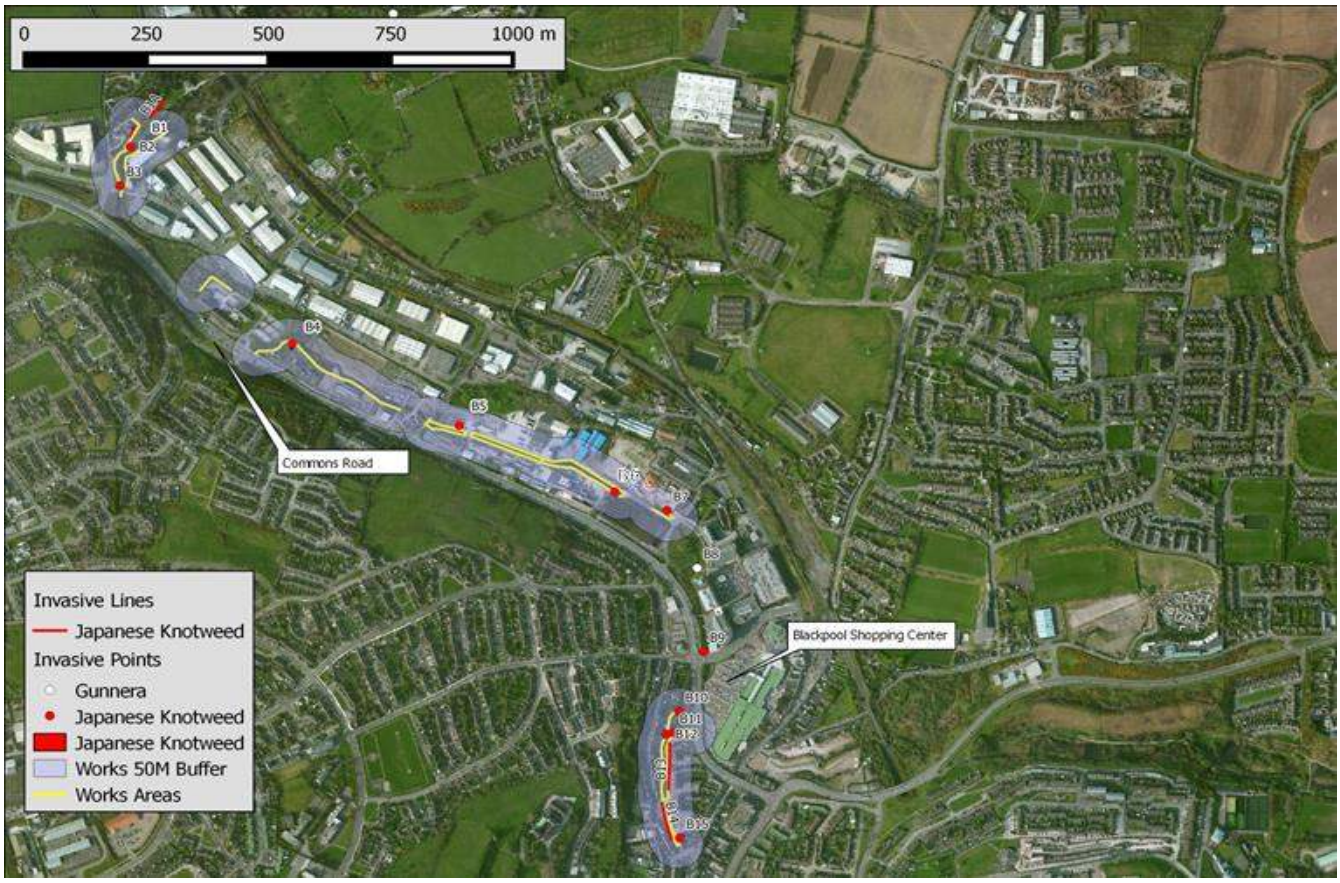

Fig 3.5:- Map showing invasive species recorded with the proposed works areas along the River Bride (North) and Glenamought River, Blackpool, Cork City. Further details are provided in Appendix I

Glenamought River (invasive species overlaps with proposed works areas)

Japanese Knotweed was the only invasive species recorded along Glenamought River channel. It was recorded at four locations. The distribution of invasive species along the Glenamought River proposed works area is shown in Fig 3.5 (above).

4. Discussion

General findings

Evidently, the two most prevalent and potentially problematic invasive species within the proposed works areas of the Lee, Curragheen, Bride (North), and Glenamought Rivers, comprising the Lower Lee Flood Relief Scheme area, are Japanese Knotweed (*Fallopia japonica*) and, to a lesser extent, Himalayan Balsam (*Impatiens glabdulifera*). These findings are in agreement with existing literature (Draft Cork County Development Plan 2013; Cork City Development Plan 2015-2021).

In addition, three other invasive species were recorded from the survey area, namely Giant Rhubarb (*Gunnera tinctoria*), Azolla Water Fern (*Azolla filiculoides*) and Nuttall's Pondweed (*Elodea nuttallii*). However these invasive plants were only locally frequent rather than colonising large corridors of river as observed with Japanese Knotweed and Himalayan Balsam. As previously stated a number of non-native species, not typically classed as invasive, such as Travellers Joy (*Clematis vitalba*) and Buddleia (*Buddleia davidii*), were especially widespread and abundant along the surveyed channels in the vicinity of Cork City but were not appraised during this study.

Detailed information on invasive species' distribution and occurrence are provided in the results section and Appendix I. This baseline information will prove valuable to local stakeholders and will be crucial in informing mitigation for the proposed Lower Lee Flood Relief Scheme. Collated data will also enable the future assessment of the spread and potential impact of invasive species along the selected channels which this survey evaluated.

Recommended Invasive Species Management (Works Areas)

Japanese Knotweed control and management

As the most abundant invasive species recorded, Japanese Knotweed is of primary concern in relation to the proposed works areas. This is particularly so along the sections of the rivers Lee such as near Wellington Bridge, and Fitzgerald's Park. The highest concentration of Japanese Knotweed recorded was on the UCC North Mall campus. The plant was also prevalent in areas along the Curragheen and Bride (North) in the vicinity of Cork City. Whilst the species currently shows a relatively intermittent distribution in most of these areas, it is likely to spread further over time especially where the soil layer is disturbed during construction activities. Flood events and mismanagement are perhaps the two major threats in expanding its distribution, as this species can regenerate from very small fragments of rhizome which may become waterborne during flood events or through ill-informed management measures such as cutting or pruning and incorrect disposal. The root system of Japanese Knotweed is typically extensive and thus traditional removal techniques often prove unsuccessful.

Japanese Knotweed occurring within or immediately adjacent to the proposed works areas should be treated as specified below according to current best practice. All works which may impact on invasive species are to be undertaken in compliance with best practice and national legislation, including best practice management guidelines such as Japanese Knotweed *Fallopia japonica* Invasive Species Ireland (Kelly *et al.,* 2008a) (Appendix A) and The Management of Noxious Weeds and Non-Native Invasive Plant Species on National Roads (NRA, 2010).

Chemical control of Japanese Knotweed is considered suitable as there is sufficient time to implement effective measures (due to localised distribution). Several different herbicides can be used to eradicate Japanese knotweed, with glyphosate, triclopyr, picloram and 2,4-D amine among the most effective during the growing season, where foliar uptake spreads the herbicide throughout the plant. As most of the stands of Japanese Knotweed are growing close to (riparian zone of) the river channels in question, only those herbicides approved for use near water should be utilised, i.e. the less persistent glyphosates or the more broad leaved-plant-selective 2-4D amine). Also consideration must be given to constraints imposed by chemicals that are persistent in the soil which may delay the planting of replacement (often native) species. It is important not to apply herbicide during wet weather when the real target (i.e. plant) is missed and the nearby watercourse receives the chemical.

To reduce the risk of Knotweed spread to uncontaminated (i.e. Knotweed-free) areas of channel and to limit future control and management costs, herbicide treatment should be applied at the earliest opportunity to the areas of Japanese knotweed, given that in-situ herbicide treatment may take between 3-5 years to be effective (Kelly *et al.*, 2008a).

Herbicide control of Japanese knotweed should follow the advice below (as per Kelly *et al.*, 2008a): -

- Herbicide treatment must be undertaken by a qualified operator and in line with relevant health and safety guidance, including that from Cork City/County Council and appropriate regulations;
- It is imperative that the manufacturer's guidelines for the chosen herbicide are adhered to;
- Two foliar applications of herbicide to leaves are recommended, once in May/June (summer growth period) and a follow-up application in September/October (pre-autumn die-back);
- Should a herbicide be utilised in the late spring/early summer (>May) period, it should be noted that the removal of Japanese Knotweed from an area may simply facilitate the colonisation by Himalayan Balsam, which produces seeds at this time. Vigilant management is required where Japanese Knotweed and Himalayan Balsam occur in close proximity (such as the River Lee) to avoid such issues;
- Herbicide can be target-sprayed onto leaves avoiding non-target vegetation and minimising herbicide drift. Herbicide can also be applied directly to target plants using a weed-wiper or herbicide glove. The application rate should follow the manufacturer's guidance;
- The operator should ensure that equipment used in treatment is cleaned prior to use elsewhere to ensure no spread of Japanese Knotweed;
- Repeated herbicide treatments over several years (3-5 years) are normally recommended for complete control of Japanese Knotweed;
- Continued monitoring of the treated areas, post herbicide application, should also be carried out to ensure that no new shoots appear. Any new shoots should be treated with herbicide as detailed above;
- Post-control native tree or shrub planting should be considered to stabilise soils and provide riparian cover;
- Japanese Knotweed can regenerate from very small fragments of rhizome (as little as 0.7g, Brock & Wade, 1992);
- Equipment that is likely to result in further spread of Japanese knotweed, such as mowers, trimmers or strimmers, should not be used on or near identified stands. Any soil, mud on boots, plant cutting and waste material containing Japanese knotweed could facilitate the further spread of this species;

Himalayan Balsam control and management

After Japanese Knotweed, the most potentially threatening invasive species present in or adjacent to the proposed works areas is Himalayan Balsam. Again, although its current distribution is localised (along the River Lee), there is a high potential for the plant to spread as a result of the proposed works for the Lower Lee Flood Relief Scheme if best practice is not first adhered to. This species reproduces through seeds which become airborne and can easily travel downstream in water. However, importantly, unlike Japanese Knotweed, Himalayan Balsam can often be successfully removed without the use of herbicides which is always the ideal scenario in invasive plant species management. The root system of Himalayan Balsam is shallow in comparison to knotweeds and other species and can be removed by hand-pulling or cutting techniques. This is the recommended course of action for the purposes of the Lower Lee Flood Relief Scheme. Herbicidal treatment (again with glyphospahte or 2-4D amine) should only be considered where large, dense stands of Himalayan Balsam reduce the feasibility of manual removal.

The removal of Himalayan Balsam typically results in the re-establishment of native riparian plant species. However, studies have shown that other invasive plant species can be more responsive in this scenario (e.g. Hulme & Bremner, 2006) which highlights the importance of a river-specific or catchment-wide invasive management plan; one that targets all invasive plant species (at least) for control.

Herbicide control of Himalayan Balsam should follow the advice below (as per Kelly *et al.*, 2008b):-

- Manual removal (hand-pulling, hand cutting) is a viable and successful removal method. Cut at ground level (the plant must be cut below the lowest node to stop regeneration) using a scythe, flail or strimmer before the flowering stage in June. Cutting earlier than this will promote greater seed production from plants that regrow. Cutting should be repeated annually until no more growth occurs;
- Control should be undertaken working from the upstream end to prevent seed recolonization. To avoid additional spread do not disturb plants if seed pods are visible. Programmes should be undertaken initially from April to mid-June prior to seed pods forming;
- For larger, denser stands a herbicide treatment can be used for Himalayan Balsam. Herbicide treatment must be undertaken by a qualified operator and in line with relevant health and safety guidance, including that from Cork City/County Council, and appropriate regulations;
- It is imperative that the manufacturer's guidelines for the chosen herbicide are adhered to;
- Plants should be sprayed in the spring before flowering but late enough to ensure that germinating seedlings have grown up sufficiently to be adequately covered by the herbicide spray;
- Herbicide can be target sprayed onto leaves avoiding non-target vegetation and minimising herbicide drift. Herbicide can also be applied directly to target plants using a weed-wiper or herbicide glove. The application rate should follow the manufacturer's guidance;
- The operator will ensure that equipment used in treatment is cleaned prior to use elsewhere to ensure no spread of Himalayan Balsam seeds;
- Repeat checks will be required on a monthly basis for any late germinating seeds. Repeat checks should be carried out each year throughout the growing season to prevent any new plants from

setting seed until no further growth is found. Any new shoots should be treated with herbicide as detailed above;

- Post-control native tree or shrub planting should be considered to stabilise soils and provide riparian cover and also to minimise the risk of colonisation by other invasive plants;

Potential impacts on habitats and/or species of conservation importance

Whilst none of the rivers within the Lee catchment are designated as Special Areas of Conservation (SAC), Cork Harbour, to which the River Lee and its tributaries discharge, is a Special Protection Area (SPA) under the EU Birds Directive (site code: 004030). It supports internationally important numbers of resident and wintering birds such as Wigeon (*Anas penelope*), Black-tailed Godwit (*Limosa limosa*) and Golden Plover (*Pluvialis apricaria*) (NPWS, 2008). Due to direct downstream connectivity, any work related activities carried out as part of the Lower Lee Flood Relief Scheme must consider the threat of spreading invasive plant species to the SPA. Studies have suggested that Japanese Knotweed has a broad salinity tolerance and may be capable of colonising estuarine and saltmarsh habitats (Richards *et al.*, 2008).

5. Further Work

Although this study focused on proposed flood relief areas on the river corridors of the Lee, Curragheen, Bride (North) and Glenamought, it is important that the potential impacts of invasive species are also assessed further up the catchment, i.e. from the sources of these rivers downstream. These areas could act as dispersal zones for seeds moving downstream and as such the full upstream extent from source areas should be established. For example the Gearagh area of the River Lee (near Macroom) has abundant Himalayan Balsam indicating that invasive plants occur high up in the catchment (pers. obs.). Pro-active management from the top of the catchment downstream will prevent invasive spread through means of containment and control. The effectiveness of follow-up control can then be appraised over time once good baseline mapping of distributions and later patterns of change have been monitored. The evidence of successful treatment would be no re-establishment of invasive species over time following the removal of stands/plants from upstream. While other means of introduction i.e. vectors are also possible the presence of invasive plants on river corridors is primarily by means of water seed dispersal and as such upstream control should prove successful. Catchment management of invasive species upstream of Inniscarra is not part of this scheme, however.

Species such as Japanese Knotweed and Himalayan Balsam have repeatedly been proven to negatively impact and alter the riparian species assemblages and the ecology, and even hydrology, of watercourses (Lecerf *et al.*, 2007; Gerber *et al.*, 2008). Without appropriate control and management, these invasive species could have wide-reaching, long terms impacts on protected Annex I birds such as Kingfisher (*Alcedo atthis*), Annex II fish species such as Atlantic salmon (*Salmo salar*) and lamprey species, and biodiversity in general within the entire catchment. Invasive plants can also cause indirect impacts through bank destabilisation and increased flooding or leaf deposition and localised siltation of fish spawning areas. As such it is important to map the distribution of invasive plants on river corridors and systematically remove from upstream to downstream contaminated areas.

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Appendix I

Database of Invasive Records

Database of Invasive Records Corresponding to GIS Mapping

River	Map Tile Area	Specific Area	Invasive Plant	Size/Area	Unique Identifier	Type	GPS Co-ordinates
Lee	Inniscarra	Inniscarra Graveyard	Nuttall's Pondweed	5m²	I1	Point	556815 , 570930
Lee	Inniscarra	Inniscarra Graveyard	Nuttall's Pondweed	10m²	I2	Point	557183, 571098
Lee	Inniscarra	Inniscarra Graveyard	Nuttall's Pondweed	5m²	I3	Point	557306, 571156
Lee	South Channel	U.C.C. Main Campus	Japanese Knotweed	5m²	SC1	Point	565992, 571417
Lee	South Channel	U.C.C. Main Campus	Japanese Knotweed	5m²	SC2	Point	566013, 571430
Lee	South Channel	U.C.C. Main Campus	Japanese Knotweed	5m²	SC3	Point	566076, 571468
Lee	South Channel	U.C.C. Main Campus	Himalayan Balsam	<5m²	SC4	Point	566108, 571466
Lee	South Channel	U.C.C. Main Campus	Japanese Knotweed	5m²	SC5	Point	566086, 571475
Lee	South Channel	U.C.C. Main Campus	Japanese Knotweed	5m²	SC6	Point	566109, 571489
Lee	South Channel	U.C.C. Main Campus	Japanese Knotweed	10m²	SC7	Point	566129, 571501
Lee	South Channel	U.C.C. Main Campus	Japanese Knotweed	Single Plant	SC8	Point	566306, 571563
Lee	South Channel	U.C.C. Main Campus	Himalayan Balsam	<5m²	SC9	Point	566314, 571561
Lee	South Channel	U.C.C. Main Campus	Himalayan Balsam	<5m²	SC10	Point	566328, 571557
Lee	South Channel	O' Donovan Rossa Road	Japanese Knotweed	5m²	SC11	Point	566371, 571542
Lee	South Channel	O' Donovan Rossa Road	Japanese Knotweed	10m²	SC12	Point	566391, 571557
Lee	South Channel	O' Donovan Rossa Road	Japanese Knotweed	5m²	SC13	Point	566390, 571536
Lee	South Channel	St. Finbarrs Road (Wandsford Quay)	Himalayan Balsam	5m²	SC14	Point	566847, 571725
Lee	South Channel	Clarkes Bridge (City Centre)	Himalayan Balsam	5m²	SC15	Point	567048, 571728
Lee	North Channel	Shakey Bridge	Japanese Knotweed	50m²	NC01	Point	565629, 571734
Lee	North Channel	Shakey Bridge	Japanese Knotweed	20m²	NC02	Point	565644, 571740
Lee	North Channel	Fitzgerald's Park (North Bank)	Gunnera	10m²	NC03	Point	565665, 571751
Lee	North Channel	Fitzgerald's Park (North Bank)	Japanese Knotweed	10m	NC04	Line	565670, 571753
Lee	North Channel	Fitzgerald's Park	Japanese Knotweed	30m	NC05	Line	565720, 571717
Lee	North Channel	Fitzgerald's Park	Gunnera	10m²	NC06	Point	565744, 571714

Lee	North Channel	Fitzgerald's Park	Gunnera	10m²	NC07	Point	565838, 571718
Lee	North Channel	Fitzgerald's Park	Japanese Knotweed	15m	NC08	Point	565858, 571767
Lee	North Channel	Fitzgerald's Park (North bank)	Gunnera	10m²	NC09	Point	565922, 571731
Lee	North Channel	Fitzgerald's Park	Gunnera	5m²	NC10	Line	565967, 571740
Lee	North Channel	Fitzgerald's Park	Gunnera	10m²	NC11	Point	565967, 571794
Lee	North Channel	Mardyke Walk (North Mall)	Japanese Knotweed	15m	NC12	Line	566201, 571907
Lee	North Channel	Mardyke Walk (North Mall)	Japanese Knotweed	10m	NC13	Line	566233, 571913
Lee	North Channel	UCC North Mall Campus	Japanese Knotweed	1464m²	NC14	Polygon	556294, 571945
Lee	North Channel	UCC North Mall Campus	Japanese Knotweed	534m²	NC15	Polygon	556388, 571924
Lee	North Channel	UCC North Mall Campus	Japanese Knotweed	622m²	NC16	Polygon	556408, 571925
Lee	North Channel	UCC North Mall Campus	Japanese Knotweed	272m²	NC17	Polygon	556417, 571975
Lee	North Channel	UCC North Mall Campus	Japanese Knotweed	20m	NC18	Line	566423, 571986
Lee	North Channel	Presentation Brothers	Himalayan Balsam	<5m²	NC19	Point	566622, 571878
Lee	Lee Fields	South Bank (Woods Farm)	Himalayan Balsam	<5m²	LF1	Point	562966, 571955
Lee	Lee Fields	South Bank (Woods Farm)	Himalayan Balsam	<5m²	LF2	Point	563003, 571934
Lee	Lee Fields	North Bank	Himalayan Balsam	10m²	LF3	Point	563169, 571894
Lee	Lee Fields	North Bank	Himalayan Balsam	Single Plant	LF4	Point	563352, 571750
Lee	Lee Fields	South Bank (Woods Farm)	Himalayan Balsam	Single Plant	LF5	Point	563352, 571674
Lee	Lee Fields	South Bank (Woods Farm)	Himalayan Balsam	Single Plant	LF6	Point	563388, 571659
Lee	Lee Fields	South Bank (Woods Farm)	Himalayan Balsam	Single Plant	LF7	Point	563418, 571645
Lee	Lee Fields	South Bank (Woods Farm)	Himalayan Balsam	Single Plant	LF8	Point	563446, 571640
Lee	Lee Fields	Carrigrohane Road	Japanese Knotweed	15m²	LF9	Point	563533, 571542
Lee	Lee Fields	North Bank - Hollymount Wetlands	Azolla Water fern	25m²	LF10	Point	563582, 571834
Lee	Lee Fields	North Bank – Hollymount	Himalayan Balsam	140m	LF11	Line	564020, 571563
Lee	Lee Fields	North Bank – Hollymount	Himalayan Balsam	130m	LF12	Line	563808, 571638
Lee	Lee Fields	South Bank - Lee Fields	Himalayan Balsam	<5m²	LF13	Point	564021, 571563

Lee	Lee Fields	South Bank - Lee Fields	Nuttall's Pondweed	<5m²	LF14	Point	564048, 571572
Lee	Lee Fields	South Bank - Lee Fields	Nuttall's Pondweed	90m²	LF15	Point	564244, 571564
Lee	Lee Fields	South Bank - Lee Fields	Nuttall's Pondweed	50m²	LF16	Point	564301, 571533
Lee	Lee Fields	North Bank - ERI building	Japanese Knotweed	15m²	LF17	Point	564428, 571543
Lee	Lee Fields	North Bank - ERI building	Nuttall's Pondweed	10m²	LF18	Point	564440, 571524
Lee	Lee Fields	North Bank - Water Treatment Plant	Nuttall's Pondweed	30m²	LF19	Point	564532, 571491
Lee	Lee Fields	North Bank - Water Treatment Plant	Nuttall's Pondweed	50m²	LF20	Point	564599, 571488
Lee	Lee Fields	Turbines	Nuttall's Pondweed	50m²	LF21	Point	564895, 571531
Lee	Lee Fields	County Hall Weir	Nuttall's Pondweed	50m²	LF22	Point	564930, 571491
Lee	Wellington Bridge	South Channel (u/s footbridge)	Himalayan Balsam	15m	WB1	Line	565114, 571425
Lee	Wellington Bridge	South Channel (u/s footbridge)	Japanese Knotweed	10m	WB2	Line	565164, 571434
Lee	Wellington Bridge	Wall bordering Park	Japanese Knotweed	30m	WB3	Line	565227, 571419
Lee	Wellington Bridge	South Channel (d/s footbridge)	Japanese Knotweed	10m	WB4	Line	565225, 571401
Lee	Wellington Bridge	Square of Japanese Knotweed	Japanese Knotweed	1557m²	WB5	Polygon	565205, 571455
Lee	Wellington Bridge	North Channel u/s Wellington Bridge	Himalayan Balsam	20m	WB6	Line	565215, 571512
Lee	Wellington Bridge	North Channel u/s Wellington Bridge	Japanese Knotweed	10m²	WB6b	Point	565178, 571478
Lee	Wellington Bridge	Sundays Well Road	Himalayan Balsam	Single Plant	WB7	Point	565249, 571598
Lee	Wellington Bridge	Mardyke	Himalayan Balsam	Single Plant	WB8	Point	565296, 571543
Lee	Wellington Bridge	Mardyke	Japanese Knotweed	10m	WB9	Line	565363, 571573
Lee	Wellington Bridge	Mardyke	Japanese Knotweed	10m	WB10	Line	565451, 571606
Curragheen	Curagheen	Atkins Farm Machinery	Japanese Knotweed	5m²	CU01	Point	564673, 571286
Curagheen	Curragheen	Atkins Farm Machinery	Japanese Knotweed	10m²	CU02	Point	564787, 571287
Curragheen	Curragheen	Atkins Farm Machinery	Japanese Knotweed	5m²	CU03	Point	564810, 571281
Curragheen	Curragheen	Atkins Farm Machinery	Japanese Knotweed	10m²	CU04	Point	564812, 571289
Curragheen	Curragheen	County Hall	Japanese Knotweed	40m	CU05	Line	564946, 571276
Bride	Blackpool	Commons Road	Japanese Knotweed	<5m²	B04	Point	566368, 574410
Bride	Blackpool	Commons Road	Japanese Knotweed	<5m²	B05	Point	567004, 574317

Bride	Blackpool	Commons Road	Japanese Knotweed	7m	B06	Point	567271, 574145
Bride	Blackpool	Commons Road	Japanese Knotweed	Single Plant	B07	Point	567375, 574108
Bride	Blackpool	Commons Road	Gunnera	Single Plant	B08	Point	567434, 573979
Bride	Blackpool	Commons Road	Japanese Knotweed	Single Plant	B09	Point	567466, 573804
Bride	Blackpool	Orchard Court	Japanese Knotweed	Single Plant	B10	Point	567396, 573668
Bride	Blackpool	Orchard Court	Japanese Knotweed	<5m^2	B11	Point	567391, 573628
Bride	Blackpool	Orchard Court	Japanese Knotweed	Single Plant	B12	Point	567369, 573620
Bride	Blackpool	Orchard Court	Japanese Knotweed	40m	B13	Line	567376, 573553
Bride	Blackpool	Orchard Court	Japanese Knotweed	20m	B14	Line	567366, 573439
Bride	Blackpool	Orchard Court	Japanese Knotweed	Single Plant	B15	Point	567394, 573401
Glenamought	Blackpool	u/s North Point Business Park	Japanese Knotweed	30m	B01A	Line	0566311, 0574970
Glenamought	Blackpool	u/s North Point Business Park	Japanese Knotweed	<5m^2	B01	Point	566296, 574936
Glenamought	Blackpool	u/s North Point Business Park	Japanese Knotweed	<5m^2	B02	Point	566273, 574898
Glenamought	Blackpool	u/s North Point Business Park	Japanese Knotweed	<5m^2	B03	Point	566248, 574813

Appendix II

Invasive Species Information Sheets

1.3 Description of particularly problematic invasive species

Detailed below are species-specific accounts of the biology and ecology of selected invasive species, as taken from Kelly *et al.,* 2008a (Japanese Knotweed), Kelly *et al.,* 2008b (Himalayan Balsam), Armstrong *et al.*, 2009 (Giant rhubarb) and Invasive Species Ireland (all accessed at http://invasivespeciesireland.com)

1.3.1 Japanese Knotweed (*Fallopia japonica*)

Habitat type: Terrestrial

Threat: Reduction of species diversity.

Habitat: Can tolerate wide range of conditions, including full shade, high temperatures, high salinity and drought. It is found near water sources, such as along river banks, low-lying and disturbed areas. It can colonize coastal shores and islands.

Description: This is a relatively large plant that can grow up to 2 – 3 m in height and can dominate an

area to the exclusion of most other plants. It can form an extensive network of rhizomes (roots) which cause problems when managing this species. Small pieces of rhizomes are capable of rejuvenating the plant. The rhizomes also allow the plant to survive over winter when the over ground conspicuous leafy part of the plant dies back to a brown wasted stem. The leaves are shield or heart shaped usually with a pale stripe down the middle. Flowers are creamy and arise from the tips of stems.

Japanese Knotweed growing along the River Lee corridor, Co. Cork

Origin and Distribution: A native of Japan, Korea, Taiwan and China where both male and female plants are known. This species is now widespread in continental Europe and Britain but only female plants have been recorded to date, including in Ireland.

Impacts: *F. japonica* is a threat in open and riparian areas where it spreads rapidly to form dense stands, excluding native vegetation and prohibiting regeneration. This reduces species diversity and alters habitat for wildlife. Once stands become established, they are extremely persistent and difficult to remove. Japanese Knotweed is also of concern to developers and private citizens. This plant has the ability to grow through tarmac and concrete (in some cases within dwellings) and therefore must be cleared completely before starting to build or lay roads.

How did it arrive in Ireland? The date of first introduction to Ireland is not know for certain. It is believed that this plant arrived in the mid to late 1800s. Regardless of the date of introduction, this plant has spread from gardens into the environment and is now a pest species.

Where is it found in Ireland? Japanese Knotweed is very common right across Ireland. It occurs in numerous different types of habitats from road sides to river corridors to waste ground in urban areas.

1.3.2 Himalayan Balsam (*Impatiens glandulifera*)

Habitat type: Terrestrial

Threat: Competition with native plants.

Habitat: riverbanks and areas of damp ground

Description: It can form dense mono-specific stands where individual plants can reach 2 – 3 m in height (one of the tallest annual plants in Ireland). The stem of the plant is smooth, hairless and hollow. They grow upright, easily broken and are usually purple in colour with many large oval shaped pointed leaves bearing teeth around the edges. The flowers of this plant can vary in colour but are usually shades of white, pink or purple. Flowering usually takes place from June to October. Seed capsules arise where the flowers were and when mature and dry, the slightest touch causes these fruits to split open explosively dispersing seeds up to 20 feet from the parent plant. Seeds are capable of further dispersal by water and animal and human aid.

Himalayan Balsam growing along the River Lee in front of the Kingsley Hotel, Cork City

Origin and Distribution: The plant is native to the western Himalayas but is now invasive in many parts of continental Europe. In Britain, Himalayan balsam is regarded as one of the top-ten most wanted species that have caused significant environmental impact.

Impacts: This species grows in thick mono-specific stands, shading out native plants such as grasses. From October onwards, the plants die back leaving the soil more exposed to erosion because of the loss of native plants earlier in the year. It has also been shown to produce more nectar in its flowers than native species making the plant more attractive to bumblebees resulting in less pollination of our native species.

How did it arrive in Ireland? It is thought to have originally arrived as an ornamental garden plant. According to O' Mahoney (2009), the plant became prominent in Ireland during the 1930's and has spread widely in Cork River systems.

Where is it found in Ireland? The species is now found throughout the island of Ireland suitable habitats. Particularly favours wetter areas with partial shading.

1.3.3 Giant rhubarb (*Gunnera tinctoria*)

Status: Established

Habitat: Terrestrial

Threat: Competition with native plants.

Habitat: coastal cliffs, waterways, roadsides, wet meadows and derelict gardens and fields.

Description: *Gunnera tinctoria* or giant rhubarb is not related to rhubarb, but as its name implies it is similar in appearance. This is a much larger plant with thorny leaves and stems. This is a large herbaceous plant that forms dense colonies and shades out other plants. This plant is most conspicuous in spring and summer when it can grow up to 2 m tall with large 'umbrella' shaped leaves that arise from sturdy stalks or petioles. *Gunnera* over-winters as large buds accumulating on the rhizomes (roots) above the surface, while the leaves die back, exposing these buds.

Giant rhubarb growing in Fitzgerald's Park, Cork City

Origin and Distribution: Native to South America but is now invasive in Europe, North America, New Zealand and Australia.

Impacts: *Gunnera* reduces the biodiversity value of infested sites. It can lead to the local extinction of some species with the formation of almost mono-specific stands of *Gunnera*. Elsewhere, this species has also caused problems by blocking drainage ditches and also access ways for people.

How did it get here? The plant arrived in Ireland as an ornamental plant for gardens.

Where is it found in Ireland? The species is currently considered invasive on the west coast of

Ireland, although it is also found on the east coast to date it is not considered invasive. It is considered to be having a significant impact on Achill Island, County Mayo, where is has spread throughout.

1.3.4 Nuttall's Pondweed (*Elodea nuttalii*)

Habitat type: Aquatic (freshwater)

Threat: Negative impacts on native macrophytes and invertebrates

Habitat: most common in calcareous waters and eutrophic waters because it has a high tissue demand for both phosphorus and nitrogen

Description: *Elodea nuttallii* originated from North America. This species is very similar to another invasive species know as *Elodea canadensis* (Canadian waterweed). Both species grow in still or slow flowing eutrophic waters but *Elodea nuttallii* has replaced *E. canadensis* at many sites possibly due to increased eutrophication. This is an aquatic weed that grows rapidly towards the surface of eutrophic freshwater systems without branching where they form a densely branched canopy. *E. nuttallii* is perennial and over winters in Ireland as horizontal shoots which regenerate new lateral shoots as the temperature reaches 6-8°C.

Nuttall's Pondweed growing along the margins of the River Lee, Co. Cork

Origin and Distribution: This species is native to North America but is now invasive in Britain where it is common.

Impacts: *E. nuttallii* tends to dominate native macrophyte communities which may lead to their local extinction. Impacts have also been recorded on invertebrate communities. This species may also have a significant impact on protected sites. *E. nuttallii* is also known to replace other invasive species as the dominant species in an impacted ecosystem. More recently data from Britain suggests that this species is now becoming replaced by *Largarosiphon major*

How did it get here? Traded as a garden plant

Where is it found in Ireland? This species now occurs at a number of sites spread right across the island. Notably, the species is known to occur in the Lee system (Carrigadrohid and Inniscarra Reservoirs; Caffrey *et al*., 2006).

Appendix 5D
Appropriate Assessment Screening Report

OIFIG na nOIBREACHA POIBLÍ
OFFICE OF PUBLIC WORKS

River Bride (Blackpool) Certified Drainage Scheme

APPROPRIATE ASSESSMENT SCREENING REPORT

November 2015

McCarthy Keville O'Sullivan
Planning & Environmental Consultants

RYAN HANLEY
CONSULTING ENGINEERS
Sherwood House, Sherwood Avenue, Taylor's Hill, Galway
Suite 11, Groundfloor, The Mall, Beacon Court, Sandyford, Dublin 18

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