River Deel (Crossmolina) Drainage Scheme fisheries habitat report

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1. Introduction

1.1 Background

This baseline report outlines the fisheries habitat and fisheries value of the River Deel in the vicinity of Crossmolina, Co. Mayo in light of the proposed Deel Drainage Scheme.

To alleviate flood risk to the town, the Office of Public Works (OPW) have proposed the construction of a diversion channel to divert flood water from the River Deel south of Crossmolina to Lough Conn. The construction phase of the River Deel (Crossmolina) Flood Relief Scheme will include construction of an 18m-wide, grass-lined diversion channel from the River Deel approx. 0.8km upstream of Crossmolina to the existing Mullenmore Springs. The proposed channel will create 'washlands' (i.e. floodplains) between the springs and Lough Conn by bypassing Crossmolina and thus reduce maximum flows in the River Deel to those which can safely pass under the soffit of Jack Garrett Bridge. To convey flood water from the River Deel to said diversion channel, it is proposed to install a new automated intake weir and reinforced concrete spillway (i.e. flood control structure) in the existing River Deel channel approx. 0.7km upstream from Jack Garrett Bridge. The proposed infrastructure has been designed in order to prevent flooding in Crossmolina Town during high flow events up to the 1% Annual Exceedance Probability (AEP) flood event, while minimising resulting changes in the hydrology of the river by avoiding any impact on river flows downstream of the intake structure for flows up to bank full flow. Please refer to Chapter 3 of the EIAR for further details.

This report constitutes a baseline appraisal of fisheries habitat along a 1.3km section of the River Deel in the vicinity of the proposed flood relief infrastructure (i.e. diversion channel and flood control structure installation). Contemporary data collated on fisheries habitat for salmonids, lamprey species, European eel and other fish species will be used to further inform the fisheries value of the River Deel in the footprint of the Drainage Scheme.

1.2 River Deel catchment

The River Deel rises in the Nephin Beg Mountains and flows in a loosely easterly direction, through Crossmolina, for approx. 45km before joining Lough Conn. The river forms an integral part of the River Moy SAC (site code: 002298), a site designated for a range of aquatic qualifying interest habitats and species including Atlantic salmon (*Salmo salar*), white-clawed crayfish (*Austropotamobious pallipes*) and otter (*Lutra lutra*) (NPWS, 2014). In the vicinity of Crossmolina town, the river flows through an area of karstic limestone and seasonally sinks underground (i.e. dries out) for prolonged periods for a reach of approx. 4km between Ballycarroon Ford and a point downstream of Crossmolina (i.e. within the survey area). It is assumed that most, if not all, of the water drains to the springs at Mullenmore, which overflow to Lough Conn.

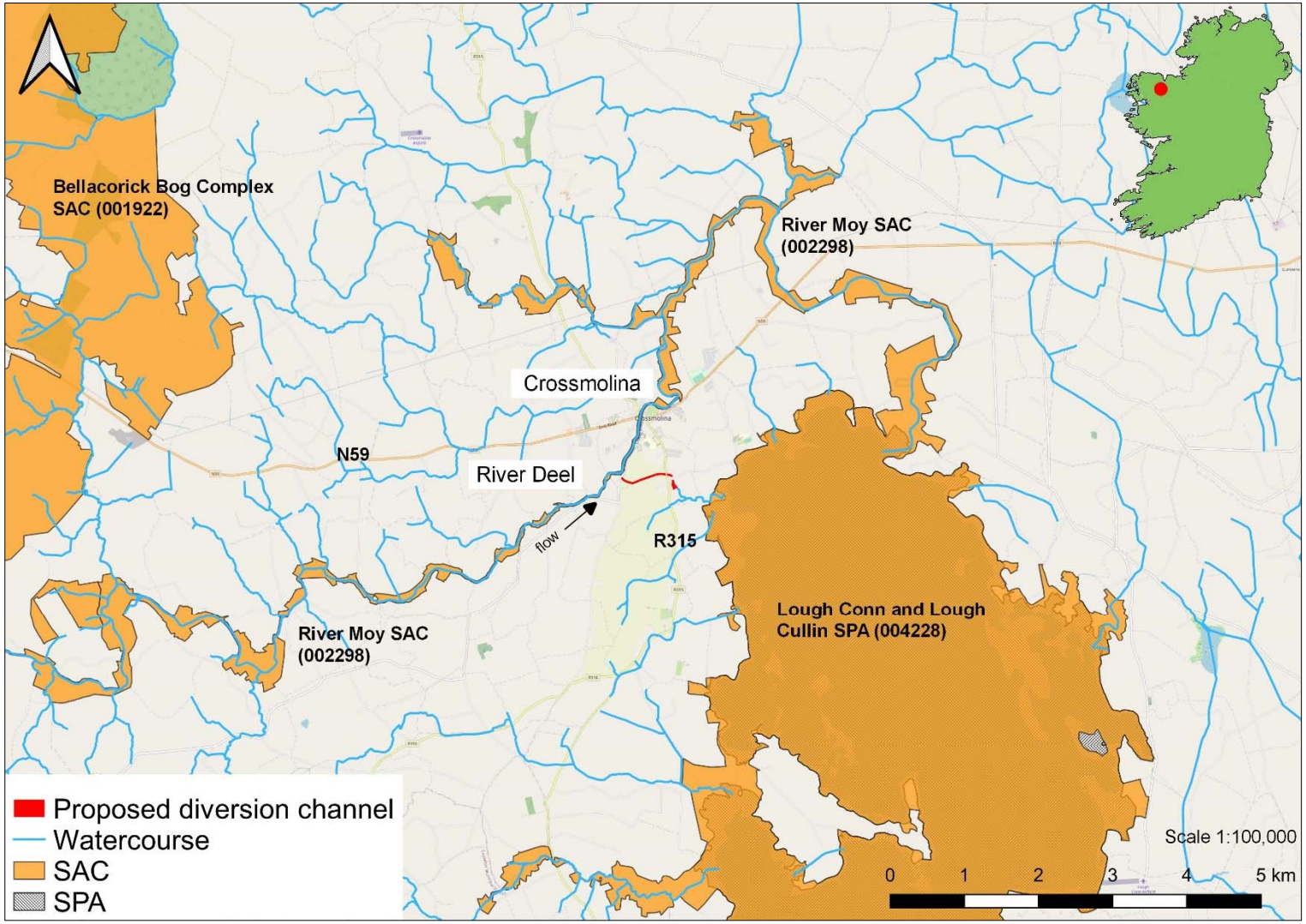

Figure 1.1 Location of the proposed drainage scheme on the River Deel near Crossmolina, Co. Mayo.

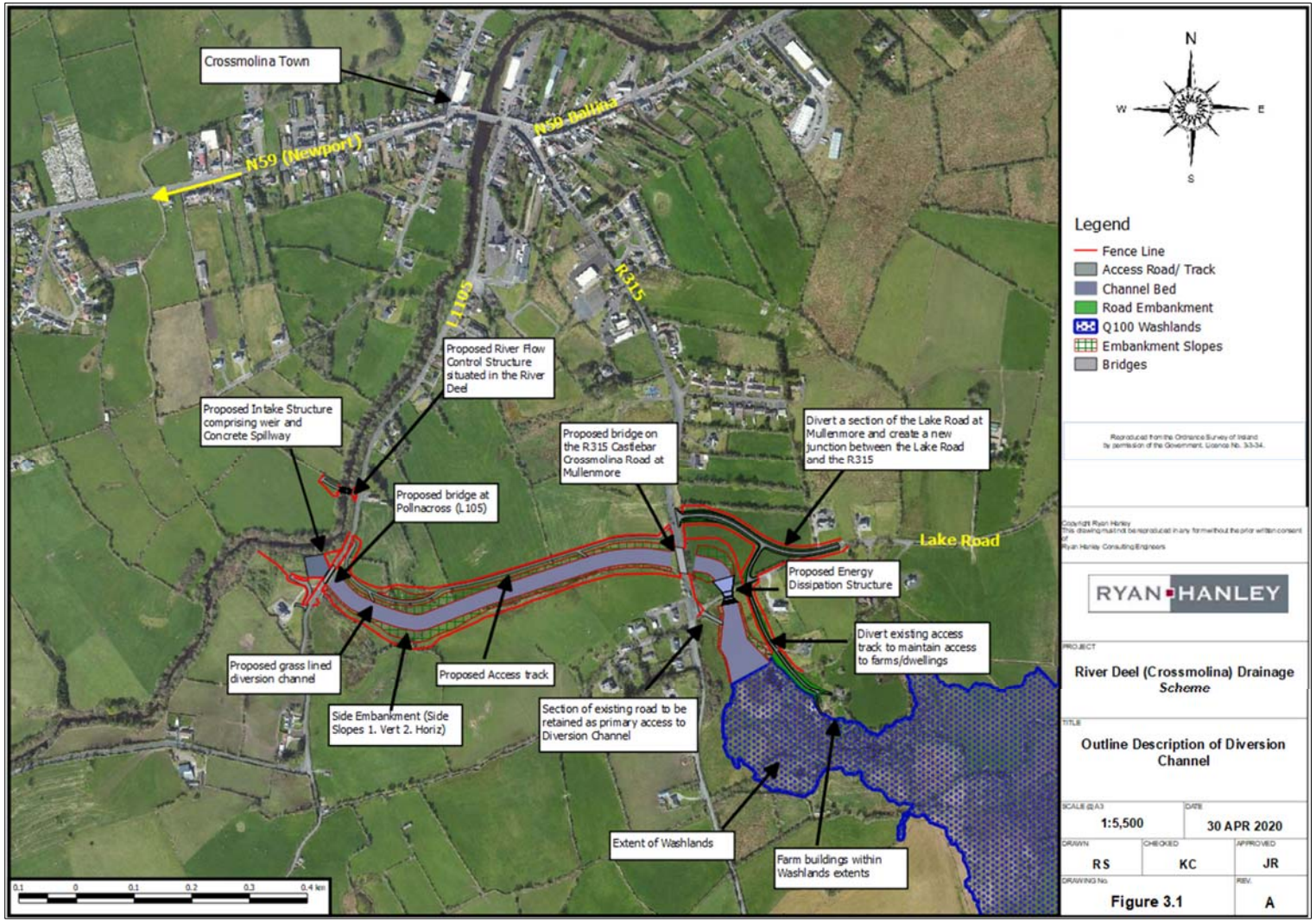

Figure 1.2 Outline description of the proposed River Deel Drainage Scheme near Crossmolina, Co. Mayo.

2. Methodology

2.1 Desktop review

A desktop review of grey and published literature was undertaken to provide baseline data on the historical and known fisheries value of the River Deel in the vicinity of Crossmolina, Co Mayo. Furthermore, consultations were held with Inland Fisheries Ireland (IFI) (Ballina) to collate additional information pertaining to fisheries value of the River Deel at Crossmolina.

2.2 Site surveys

Following a baseline review of the river (once targeted knowledge of the river had been attained), a site survey was undertaken on Tuesday May 12th 2020. In total, approx. 1.3km of the River Deel was surveyed, extending from the large meander upstream of the proposed flood control structure (Chapel Road area) to approx. 0.2km downstream of Jack Garrett Bridge (see Figure 2.1).

To facilitate increased data resolution, the survey reach was divided into 13 No. 100m lengths (see Figure 2.2). Within each survey section the physical river characteristics were recorded in terms of substrata, profile (i.e. riffle, pool, glide), instream vegetation (macrophytes and bryophytes) and a general riparian summary. The proportions of each substrate type were estimated according to the sizes provided by Fluskey (1989). Appraisals of each survey section were conducted utilising elements of the methodology given in the Environment Agency's 'River Habitat Survey in Britain and Ireland Field Survey Guidance Manual 2003' (EA, 2003) and the Irish Heritage Council's 'A Guide to Habitats in Ireland' (Fossitt, 2000). Furthermore, an appraisal of fisheries habitat was undertaken for each survey section (see 2.3 below).

2.3 Fisheries habitat

A fisheries habitat appraisal of the 13 No. River Deel survey sections (see Figure 2.2) was undertaken to establish their importance for salmonid, lamprey, European eel and other fish species. The baseline assessment considered the quality of spawning, nursery and holding habitat within the vicinity of the survey sites using Life Cycle Unit (salmonids) and Lamprey Habitat Quality Index scores (lamprey). The evaluation of higher and lower value survey sections, and areas within, will be used to inform fisheries mitigation for the Deel Drainage Scheme.

Salmonids

Fisheries habitat for salmonids was assessed using the Life Cycle Unit method (Kennedy, 1984; O'Connor & Kennedy, 2002) to map survey sections as nursery, spawning and holding water, by assigning quality scores to each type of habitat. According to the method, those habitats with poor quality substrata, shallow depth and a poorly defined river profile receive a higher score. Higher scores in the Life Cycle Unit method of fisheries quantification are representative of poorer value, with lower scores being more optimal, despite this appearing counter-intuitive. Overall scores are calculated as a simple function of the sum of individual habitat scores.

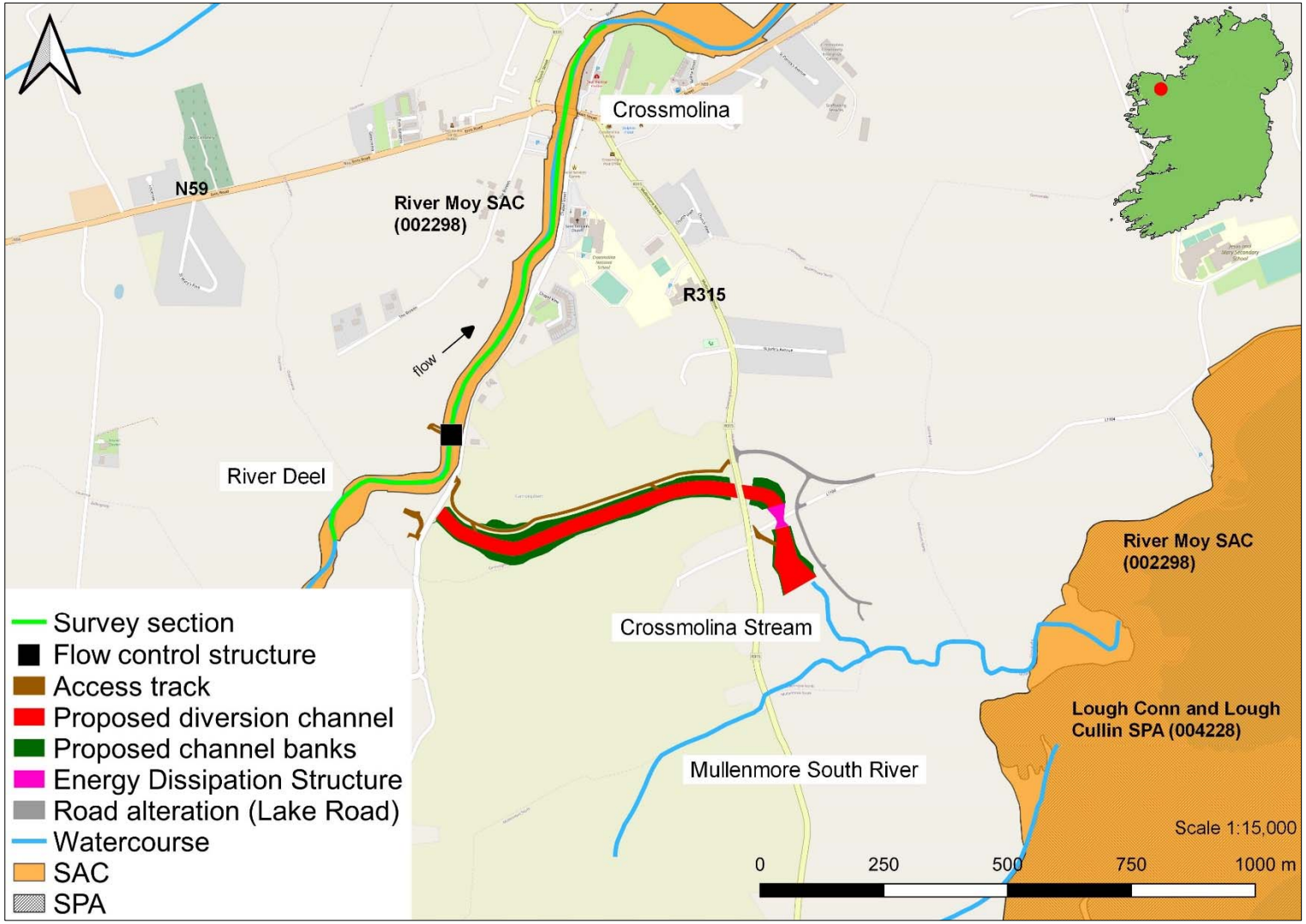

Figure 2.1 Overview of the survey area for the Deel Drainage Scheme, Crossmolina, Co. Mayo. May 2020.

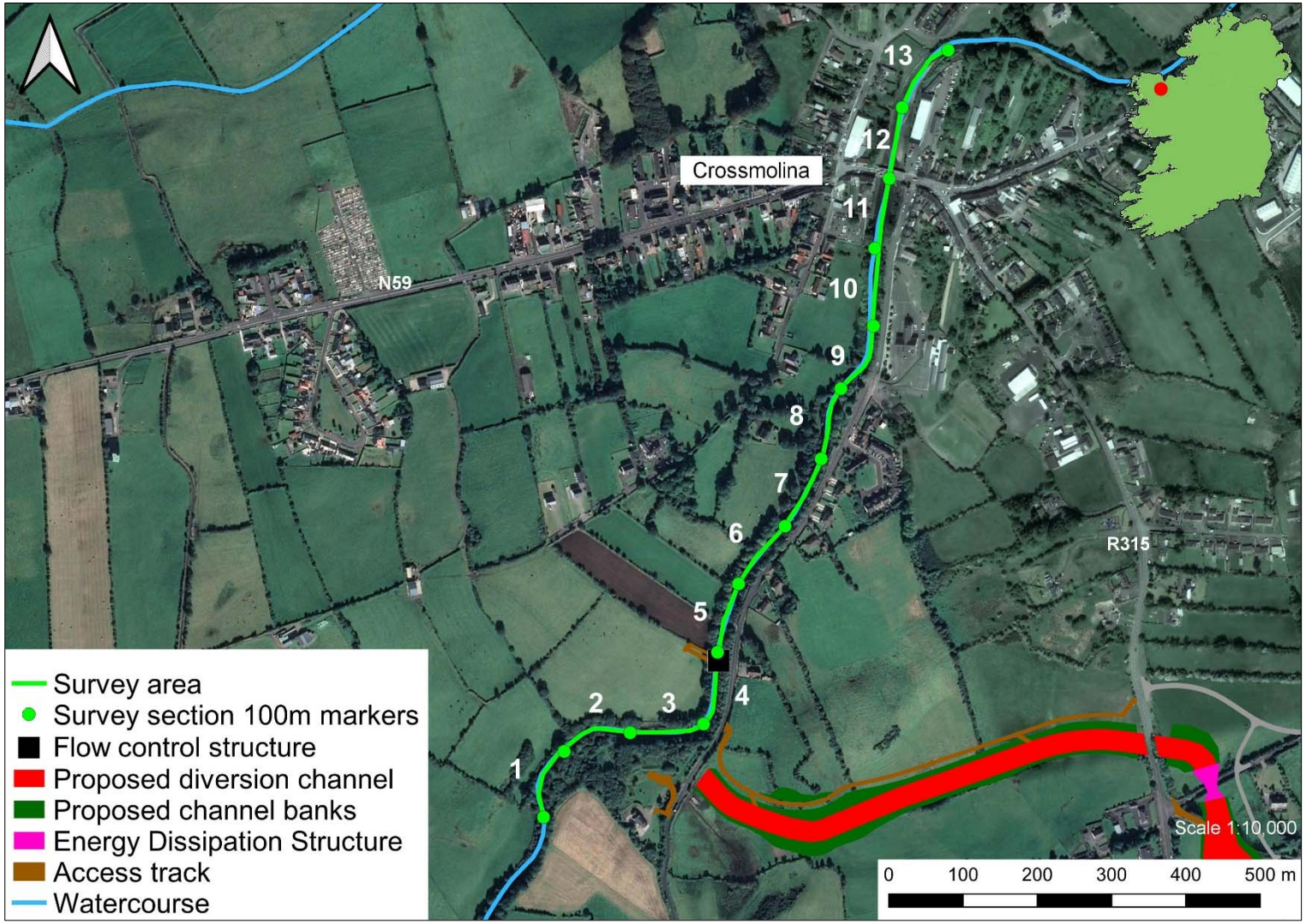

Figure 2.2 Overview of the 13 No. River Deel fisheries habitat survey sections.

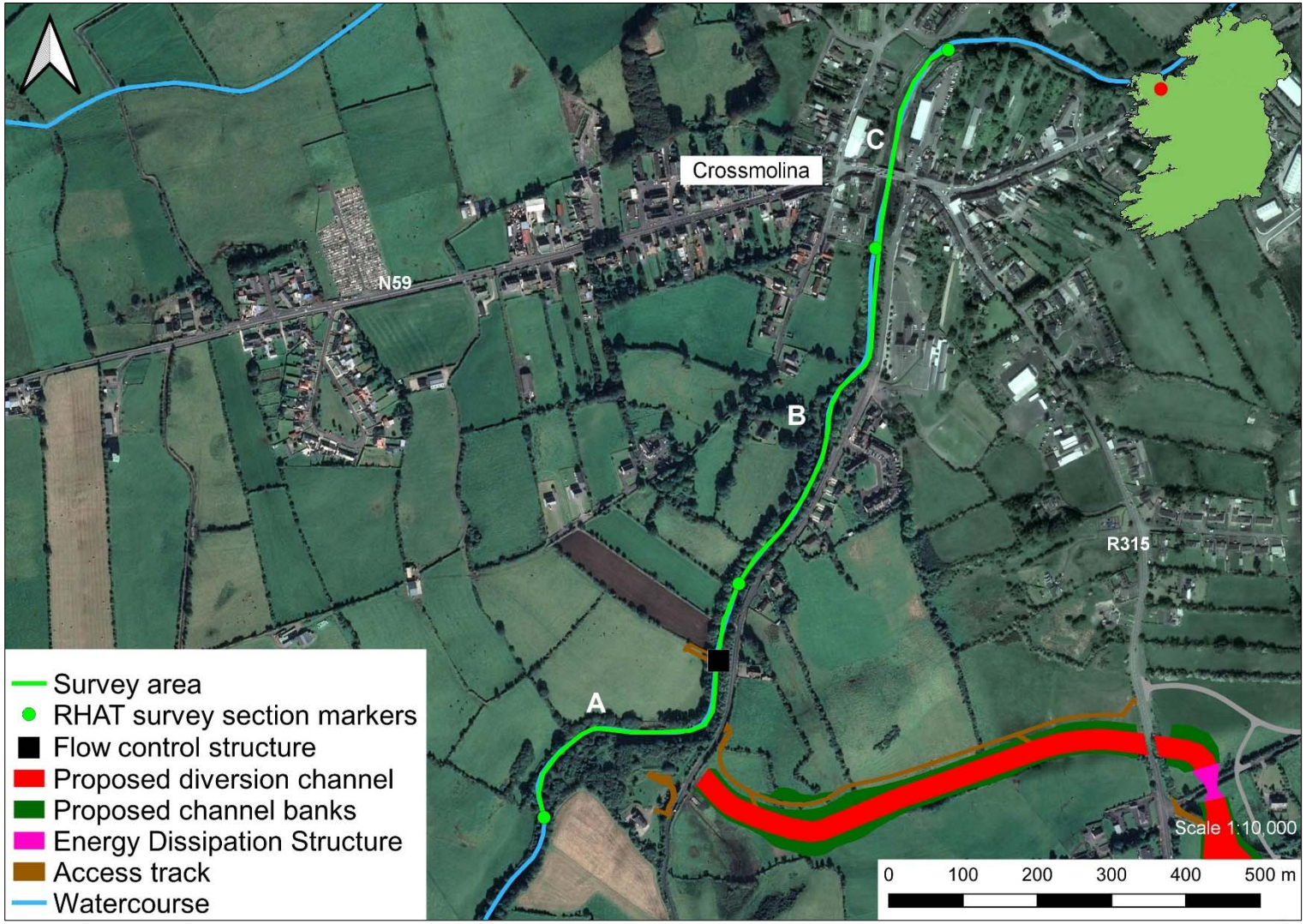

Figure 2.3 Overview of the 3 No. River Deel RHAT survey sections.

Table 2.1 Life Cycle Unit scoring system for salmonid nursery, spawning and holding habitat value as determined for each component (as per Kennedy, 1984; O'Connor & Kennedy, 2002).

Habitat quality	Habitat score	Total score for three components
Poor	4	12
Moderate	3	9-11
Good	2	6-8
Excellent	1	3-5

Lamprey species

Lamprey habitat evaluation within each survey section was undertaken using the Lamprey Habitat Quality Index (LHQI) scoring system, as devised by Macklin et al. (2018). The LHQI broadly follows a similar rationale as the Life Cycle Unit score for salmonids. Those habitats with a lack of soft, largely organic sediment areas for ammocoete burrowing, shallow sediment depth (<10cm) or compacted sediment nature receive a higher score. Higher scores in this index are thus of poorer value (in a similar fashion to the salmonid Life Cycle Unit Index), with lower scores being more optimal. Overall scores are calculated as a simple function of the sum of individual habitat scores.

Larval lamprey habitat quality as well as the suitability of adult spawning habitat is assessed based on the information provided in Maitland (2003) and other relevant literature (e.g. Gardiner, 2003). Unlike the salmonid Life Cycle Unit index, holding habitat for adult lamprey is not assessed owing to their different migratory and life history strategies, and that electro-fishing surveys routinely only sample larval lamprey.

The LHQI scoring system provides additional information compared to the habitat classification based on the observations of Applegate (1950) and Slade et al. (2003), which deals specifically with larval (sea) lamprey settlement habitat. Under this scheme, habitat is classified into three different types: preferred (Type 1), acceptable (Type 2), and not acceptable for larvae (Type 3) (Slade et al. 2003). Type 1 habitat is characterized by soft substrate materials usually consisting of a mixture of sand and fine organic matter, often with some cover over the top such as detritus or twigs in areas of deposition. Type 2 habitat is characterized by substrates consisting of shifting sand with little if any organic matter and may also contain some gravel and cobble (lamprey may be present but at much lower densities than Type 1). Type 3 habitat consists of materials too hard for larvae to burrow including bedrock and highly compacted sediment. This classification can also be broadly applied to other lamprey species ammocoetes, including *Lampetra* species.

Table 2.2 Lamprey Habitat Quality Index (LHQI) scoring system for lamprey spawning and nursery habitat value (Macklin et al., 2018).

Habitat quality	Habitat score	Total score for two components
Poor	4	8
Moderate	3	6 - 7
Good	2	3 - 5
Excellent	1	2

2.4 River hydromorphology

In order to evaluate and catalogue the degree of riverine habitat 'naturalness' in terms of overall ecology and fisheries value, the River Hydromorphological Assessment Technique (RHAT) was used (Murphy & Toland, 2014).

RHAT expands on the previous standards for river surveys, such as the River Habitat Survey (RHS) methodology (EA, 2003). It is assumed that natural systems support ecology better than modified systems. Hence, the RHAT method classifies river hydromorphology based on a departure from naturalness and allows for the assignment of a morphological classification directly related to Water Framework Directive (WFD) status (Table 2.2), i.e. High, Good, Moderate, Poor or Bad. Score calculation is based on eight semi-qualitative and quantitative hydromorphological criteria, namely:

- Channel morphology and flow types
- Channel vegetation
- Substrate diversity and condition
- Barriers to continuity
- Bank structure and stability
- Bank and bank top vegetation
- Riparian land use
- Floodplain interaction

RHAT is designed to be a holistic visual assessment based on information from both desktop and field (walkover) studies incorporating GIS data, aerial (ortho) photography and historical data. The RHAT method was developed for WFD classification, but it also has other applications including assessing morphological pressures at a site and inferring fisheries value (see Results, Discussion).

RHAT walkover surveys were undertaken along the survey reaches of the River Deel during a high vegetative growth period, i.e. May 2020, when plant and macrophyte species are readily identifiable. Following best practice (Murphy & Toland, 2014), the River Deel was assessed in discrete 500m sections, along both banks (sections A, B and C; see Figure 2.3).

Table 2.2 RHAT hydromorph scores and their corresponding Water Framework Directive (WFD) classification (Murphy & Toland, 2014).

Hydromorph score	WFD Status
≥0.8	High Status
≥0.7 ≤0.8	Good Status
≥0.5 ≤0.6	Moderate Status
≥0.3 ≤0.4	Poor
≤0.2	Bad

2.5 Biosecurity

A strict biosecurity protocol including the Check-Clean-Dry approach was adhered to during the survey for all equipment and PPE used. Disinfection of all equipment and PPE before use with Virkon™ was conducted to prevent the transfer of pathogens or invasive propagules between survey sites. Surveys were undertaken at sites in a downstream order to minimise the risk of upstream propagule mobilisation. Any invasive species were noted and geo-referenced.

3. Results

3.1 Desktop review (fisheries value)

The River Deel is a designated salmonid watercourse under the European Communities (Quality of Salmonid Waters) Regulations 1988 (S.I. No. 293/1988) and is a renowned recreational Atlantic salmon fishery. The river is also known to support brown trout (*Salmo trutta*), pike (*Esox lucius*), roach (*Rutilus rutilus*), perch (*Perca fluviatilis*), Red-listed European eel (*Anguilla anguilla*), three-spined stickleback (*Gasterosteus aculeatus*) and minnow (*Phoxinus phoxinus*) (Kelly et al., 2012, 2009; O'Connor, 2004). The Deel supports spawning sea lamprey (*Petromyzon marinus*) as far upstream as Ballycarroon Falls (in relatively high densities), approx. 1.5km upstream of the survey area, with *Lampetra* sp. also present both upstream and downstream Crossmolina (O'Connor, 2004). Extensive lamprey habitat was noted by O' Connor (2004) in the River Deel both in the undrained reaches of the river upstream of Crossmolina and in some drained stretches downstream of Crossmolina.

Furthermore, the River Deel supports a significant freshwater pearl mussel (*Margaritifera margaritifera*) population, with counts estimated at >100,000 adults by Moorkens & Killeen (2009). Survey work undertaken in 2017 for the Deel Drainage Scheme identified >1000 live mussels in the c.300m of River Deel channel in the vicinity of the proposed flood control structure and diversion channel construction (please refer to Chapter 5 of the EIAR for more details). The River Deel also supports white-clawed crayfish throughout the system (please refer to Chapter 5 of the EIAR for more details)

3.2 Survey section descriptions

The following summarises the findings of site walkover surveys for each of the 13 No. 100m-length survey sections on the main River Deel channel in terms of physical river characteristics, instream and riparian vegetation assemblages/habitats and fisheries value. Please note that the river was mostly dry at the time of survey, with localised pools of standing water only.

Section 1

Survey section 1 was located approx. 1km upstream of Jack Garrett Bridge in Crossmolina and approx. 0.2km upstream of the proposed location of the flow control structure installation (Figure 2.2). The section was located on a large meander. The river averaged 15m in width but was largely dry at the time of survey, with only one small pool of standing water located at the downstream extent of the survey section; this area supported abundant 1+ salmonids (>40 individuals) and averaged 0.2-0.3m in depth. The substrata were dominated by clean cobble (40%) and very coarse gravel (25%) with occasional boulder in addition to low fractions of coarse, medium and fine gravel in interstitial spaces. Soft substrata were largely absent.

Although dry at the time of survey, the section was considered to offer good salmonid nursery, spawning and holding habitat during wetted periods (Table 3.1), given the glide and pool-dominated profile. Spawning habitat for lamprey was poor (section dominated by larger hard substrata) although a single small patch of sand with a limited organic silt component was present

along the west bank at the downstream end of the section; this offered some moderate value for larval lamprey during wetted periods (Table 3.2). European eel habitat was considered good in general given the presence of evident pool habitat and larger substrata.

Section 1 was adjoined by improved agricultural grassland (GA1; Fossitt, 2000) fields on both banks with the riparian zone comprised of mature treelines supporting sycamore (*Acer psuedoplatanus*), ash (*Fraxinus excelsior*) and hawthorn (*Crataegus monogyna*) with frequent grey willow (*Salix cinerea*) and occasional dog rose (*Rosa canina*) and blackthorn (*Prunus spinosa*), Shading was moderate. The ground flora comprised common species such as ivy (*Hedera helix*), bluebell (*Hyacinthoides non-scripta*) and ground elder (*Aegopodium podagraria*). Instream vegetation was limited to localised patches of smaller lattice-moss (*Cinclidotus fontinaloides*) on larger boulders. Hemlock water dropwort (*Oenanthe crocata*) and marsh marigold (*Caltha palustris*) were occasional along river margins.

Plate 3.1 Representative image of survey section 1 on the River Deel, showing pool of standing water.

Section 2

Survey section 2 was located approx. 1km upstream of Jack Garrett Bridge in Crossmolina and approx. 0.2km upstream of the proposed location of the flow control structure installation (Figure 2.2). The section was located on a large meander with a bank height variable between 2m (south bank) and 8m (north). The river averaged 15m in width but was 100% dry at the time of survey (no pools of standing water present). The substrata were dominated by clean cobble (40%) and very coarse gravel (25%) with occasional boulder (10%) in addition to low fractions of coarse, medium and fine gravel with sand in interstitial spaces. Silt was absent.

Although dry at the time of survey, the section was considered to offer excellent salmonid holding habitat during wetted periods (Table 3.1), by virtue of a large deep pool situated on the meander.

Nursery and spawning habitat for salmonids were considered to be of good quality during wetted periods, given the deep glide profile present. Spawning habitat for lamprey was poor (section dominated by larger hard substrata) although a small patch of sand with a limited organic silt component was present on the inside of the meander (south bank); this offered some moderate value for larval lamprey during wetted periods (Table 3.2). European eel habitat was considered good in general given the presence of evident pool habitat and larger substrata for refugia.

To the north, section 2 was adjoined by improved agricultural grassland (GA1) with a mature riparian zone comprised mainly of mature sycamore, willow and hazel (*Corylus avellana*). A mosaic of wet willow-dominated woodland (WN6) and mixed broad-leaved woodland (WD1) bordered the river channel to the south. The riparian zone and treeline understorey supported hogweed (*Heracleum sphondylium*), wood anemone (*Anemone nemorosa*), ground elder, cow parsley (*Anthriscus sylvestris*), wood avens (*Geum urbanum*), bluebell, pignut (*Conopodium majus*), lesser celandine (*Ficaria verna*), hart's tongue (*Asplenium scolopendrium*), bramble (*Rubus fruticosus* agg.) and blackthorn. Shading was moderate along the deeper north bank of the section, with more open habitat to the south. Instream vegetation was limited to localised patches of *Cinclidotus fontinaloides* on larger boulders. Hemlock water dropwort and marsh marigold were occasional along river margins.

Section 3

Survey section 3 was located adjacent to the proposed diversion channel site (Figure 2.2). The section featured a straight section of 100% dry glide habitat with a large meander and associated deep pool habitat present at the downstream extent. The bank height was variable, between 2m (south bank) and 8m (north). As per upstream, the river averaged 15m in width but was 100% dry at the time of survey (no pools of standing water present). The substrata were dominated by very coarse gravel (30%), coarse gravel (20%) and cobble (20%), with lower fractions of medium gravel, fine gravel, sand and boulder. Bedrock comprised approx. 5% of the substrata (mostly in the vicinity of the meander). Silt was absent.

Although dry at the time of survey, the section was considered to offer combination of good salmonid nursery, spawning and holding habitat during wetted periods (Table 3.1), given the presence of homogenous deep glide profile and deeper pool areas. Spawning and nursery habitat for lamprey were poor (Table 3.2), with the section dominated by larger hard substrata with no soft sediment areas for larval settlement. European eel habitat was considered good in general given the presence of evident pool habitat and larger substrata for refugia.

To the north, section 3 was adjoined by improved agricultural grassland (GA1) with a mature riparian zone comprised mainly of mature sycamore, willow and ash, with an understorey of wood anemone, Hart's tongue, ivy, hemlock water dropwort and cow parsley. A mosaic of wet willow-dominated woodland (WN6) and mixed broad-leaved woodland (WD1) bordered the river channel to the south (as per section 2). Shading was moderate throughout. Instream vegetation was limited to localised patches of *Cinclidotus fontinaloides* on larger boulders. Hemlock water dropwort and marsh marigold were present locally on exposed marginal cobble.

Plate 3.2 Representative image of survey section 3 on the River Deel, facing downstream towards the meander, adjacent to the site of proposed diversion channel.

Section 4

The proposed location for the flood control structure associated with the diversion channel was located at the downstream extent of section 4 (Figure 2.2). The straight section featured 100% dry glide and pool habitat (both 50% coverage). The bank height varied between 2m (west bank) and 10m (east). As per upstream, the river averaged 15m in width but was 100% dry at the time of survey (no pools of standing water present). The substrata were dominated by boulder (30%) and clean coarse gravel (30%) with frequent cobble and very coarse gravel. Lower fractions of medium gravel, fine gravel and sand were present (all 5%). Silt was absent.

Although dry at the time of survey, the section was considered to offer good salmonid nursery, and holding habitat during wetted periods (Table 3.1). Salmonid spawning habitat was less suitable than upstream given higher compaction of substrata (still moderate value overall). Spawning and nursery habitat for lamprey was poor (Table 3.2), with the section dominated by larger hard substrata with no soft sediment areas for larval settlement. European eel habitat was considered good in general given the presence of evident pool habitat and ample boulder refugia.

To the west, section 4 was adjoined by improved agricultural grassland (GA1) with a mature riparian treeline of sycamore, willow and ash, with an understorey of wood anemone, Hart's tongue, ivy, hemlock water dropwort and cow parsley. A similarly mature treeline of sycamore, willow, ash and occasional alder (*Alnus glutinosa*) and beech (*Fagus sylvatica*) was present on the steeply sloping, high east bank. Shading was moderate throughout. As per upstream sections, instream vegetation was limited to localised patches of *Cinclidotus fontinaloides* on larger boulders. Hemlock water dropwort and marsh marigold were present locally on exposed marginal cobble.

Plate 3.3 Representative image of survey section 4 on the River Deel, at the location of the proposed flood control structure.

Section 5

Section 5 was located immediately downstream of the proposed flood control structure (Figure 2.2). The straight section was dominated by a glide profile (70%) with occasional pool and shallower areas likely represented by riffles during wetted periods. The bank height averaged between 2-4m (much lower gradient and height than upstream). The channel averaged 12m in width but was 100% dry at the time of survey (no pools of standing water present). As per section 4, the substrata were dominated by boulder and clean coarse gravel (both 30% each) with frequent cobble and very coarse gravel. Lower fractions of medium gravel, fine gravel and sand were present (all 5%). Silt was absent.

Although dry at the time of survey, the glide-dominated section was considered to offer good salmonid nursery habitat. However, the paucity of pools and more compacted/bedded substrata (indicative of a higher flow area) reduced the quality of salmonid spawning and holding habitat during wetted periods compared with upstream (Table 3.1). Nursery habitat for lamprey was poor (Table 3.2) given the lack of soft sediment areas although some moderate spawning habitat was present in interstitial spaces between boulder and cobble. European eel habitat was considered good in general given the presence of ample boulder refugia and overhanging/submerged woody vegetation.

Section 5 was adjoined by improved agricultural grassland (GA1) to the west with riparian treelines on both banks dominated by grey willow, localised ash and sycamore (all mature). Bramble, ground elder, montbretia (*Crocosmia* x *crocosmiflora*), Hart's tongue, water figwort (*Scrophularia auriculata*), wood anemone and nettle dominated the understorey. Instream vegetation was limited to localised patches of *Cinclidotus fontinaloides* on larger boulders. Hemlock water dropwort was present locally in marginal areas.

Section 6

Section 6 was located approx. 0.1km downstream of the proposed flood control structure (Figure 2.2). Similar to section 5, the straight section was dominated by a glide profile (70%) with occasional pool and shallower areas likely represented by riffles during wetted periods. The bank height averaged between 2-4m (much lower gradient and height than further upstream). The channel averaged 12m in width but was 100% dry at the time of survey (no pools of standing water present). The substrata were dominated by boulder and clean coarse gravel (both 30% each) with frequent cobble and very coarse gravel. Lower fractions of medium gravel, fine gravel and sand were present (all 5%). Silt was absent.

Although dry at the time of survey, the glide-dominated section was considered to offer good salmonid nursery and holding habitat (Table 3.1), given the presence of deep glide profile and occasional deeper pooling areas. However, the compacted/bedded substrata (indicative of a higher flow area) reduced the quality of salmonid spawning habitat (moderate only) compared to further upstream (Table 3.1). Nursery habitat for lamprey was poor (Table 3.2) given the lack of soft sediment areas although some moderate spawning habitat was present in interstitial spaces between boulder and cobble. European eel habitat was considered good in general given the presence of ample boulder refugia and overhanging/submerged woody vegetation.

Section 6 was adjoined by improved agricultural grassland (GA1) to the west and a local access road to the east, with riparian treelines on both banks dominated by grey willow, localised ash and sycamore (all mature). Bramble, ground elder, montbretia, Hart's tongue, water figwort, wood anemone and nettle dominated the understorey. Instream vegetation was limited to localised patches of *Cinclidotus fontinaloides* on larger boulders. Hemlock water dropwort was present locally in marginal areas. Small stands (<2m^2) of Japanese knotweed (*Fallopia japonica*) were present locally, approximately halfway along the section on the east bank. Three regular otter spraint sites, containing white-clawed crayfish fragments, were noted on large instream boulders throughout the section.

Section 7

Section 7 was located approx. 0.2km downstream of the proposed flood control structure (Figure 2.2). The section comprised 100% pool habitat at the time of survey, with standing water averaging 0.2->1m in depth. The channel averaged 12m in width with a bank height of 2-4m. In contrast to upstream sections, the substrata were dominated by clean cobble (30%), very coarse gravel (20%) and coarse gravel (20%), with only occasional boulder (10%) and low fractions of medium and fine gravel. Silt and sand accumulations were absent although the pool habitat encouraged some limited settlement of fine debris on the substrata.

The pool-dominated section offered excellent salmonid holding habitat (Table 3.1). Nursery and spawning habitat were both good, with juvenile salmonids of mixed cohorts abundant in the pool at the time of survey. The substrata were generally less compacted compared with upstream sections. Nursery habitat for lamprey was poor (Table 3.2) given the lack of soft sediment areas although some moderate spawning habitat was present in interstitial spaces between boulder and cobble. European eel habitat was considered good in general given the presence of deeper pool areas and large woody debris refugia in channel margins.

Section 7 was adjoined by improved agricultural grassland (GA1) to the west and a local access road to the east, with riparian treelines on both banks dominated by grey willow with frequent sycamore and ash. The understories supported typical species such as broad-leaved dock (*Rumex obtusifolius*), guelder rose (*Viburnum opulus*), bramble, ivy, ground elder, montbretia, Hart's tongue, water figwort, wood anemone and nettle. Instream vegetation was limited to localised patches of *Cinclidotus fontinaloides* on larger boulders. Hemlock water dropwort was frequent throughout with occasional marsh marigold in marginal areas. Japanese knotweed was scattered throughout the riparian zone.

Section 8

Section 8 was located approx. 0.3km downstream of the proposed flood control structure (Figure 2.2). The section comprised 100% pool habitat at the time of survey, with standing water averaging 0.2->1m in depth (the same pool as section 7 upstream). The channel averaged 12m in width with a bank height of 2-4m. The substrata were dominated by very coarse and coarse gravel (both 30%) and cobble (20%), with only occasional boulder (5%; less than upstream section) and low fractions of medium and fine gravel. Silt and sand accumulations were absent although the pool habitat encouraged some limited settlement of fine debris on the substrata.

The pool-dominated section offered excellent salmonid holding habitat (Table 3.1). Nursery and spawning habitat were both good, with juvenile salmonids of mixed cohorts abundant in the pool at the time of survey. The substrata were generally less compacted compared with upstream sections (e.g. sections 3, 4, 5). Nursery habitat for lamprey was poor (Table 3.2) given the lack of soft sediment areas although some moderate spawning habitat was present in interstitial spaces between boulder and cobble. European eel habitat was considered good in general given the presence of deeper pool areas and large woody debris refugia in channel margins.

Section 8 was adjoined by improved agricultural grassland (GA1) to the west and a local access road to the east, with riparian treelines on both banks dominated by grey willow with frequent sycamore and ash. The understories supported typical species such as broad-leaved dock, guelder rose, bramble, ivy, ground elder, montbretia, Hart's tongue, water figwort, wood anemone and nettle. Instream vegetation was limited to localised patches of *Cinclidotus fontinaloides* on larger boulders. Hemlock water dropwort was frequent throughout with occasional marsh marigold in marginal areas.

Plate 3.4 Representative image of survey section 8 on the River Deel, showing deep remnant pool habitat (facing downstream to section 9).

Section 9

Section 9 was located approx. 0.4km downstream of the proposed flood control structure (Figure 2.2). The section was dominated by a glide profile (70%) but was semi-dry at the time of survey. However, a deep pool of standing water was present at the downstream end of the section, accounting for approximately a third of the 100m reach. The depth varied from 0.5 to 1.5m. The channel averaged 10-12m in width with a bank height of 2-3m. The substrata were dominated by cobble, very coarse and coarse gravel (all 20%), with occasional boulder, medium and fine gravel (all 10%). Some sand was present locally.

The section offered excellent salmonid holding habitat in the deep pool area (Table 3.1). Nursery and spawning habitat were both considered good during wetted periods, with salmonids of mixed cohorts (juveniles and adults) abundant in the pool at the time of survey. A particularly suitable spawning area of small cobble/very coarse gravel was located immediately upstream of the deep pool area. Nursery habitat for lamprey was moderate (Table 3.2) given the presence of localised sand patches (sub-optimal habitat), with some moderate spawning habitat present in interstitial spaces. European eel habitat was considered good in general given the presence of deeper pool areas and frequent large woody debris refugia instream.

Section 9 was adjoined by improved agricultural grassland (GA1) to the west and built land (BL3) to the east, with riparian treelines on both banks dominated by sycamore and grey willow. The understories supported typical species such as broad-leaved dock, ivy and nettle. Instream vegetation was limited to localised patches of *Cinclidotus fontinaloides* on larger boulders, which was more frequent than upstream sections. Hemlock water dropwort was frequent throughout marginal areas.

Section 10

Section 10 was located approx. 0.2km upstream of Jack Garrett Bridge (Figure 2.2). The section was dominated by pool habitat (60%) supporting standing water at the time of survey (two main areas). However, some of the section was dry at the time of survey (considered to be glide habitat during wetted periods). The depth of the pools averaged 0.3-0.5m. The channel averaged 12-15m in width with a bank height of 3-4m. The substrata were well-mixed in comparison to upstream areas. Cobble dominated (40%) with frequent very coarse gravel (20%) and boulder (15%). Coarse gravel was occasional (10%) along with sand, fine gravel and medium gravel locally in interstitial spaces. Soft sediment accumulations were absent.

The section offered good salmonid holding habitat in the deep pool areas (Table 3.1). Nursery and spawning habitat were also considered good during wetted periods, with salmonids of mixed cohorts (juveniles and adults) abundant in the pool at the time of survey. Nursery habitat for lamprey was poor (Table 3.2) given the absence of soft sediment areas. Spawning habitat was considered moderate, with some suitable smaller substrata present throughout. European eel habitat was considered good in general given the presence of deeper pool areas and occasional boulder refugia.

Section 10 was adjoined by improved agricultural grassland (GA1) to the west and built land (BL3) to the east, with riparian treelines on both banks dominated by sycamore with more localised grey willow, crack willow (*Salix fragilis*), ash and elder (*Sambucus nigra*). Exuberant growth of ground elder, butterbur (*Petasites hybridus*), cow parsley, nettle, ivy and bramble was present in riparian understories. Instream vegetation was limited to localised patches of *Cinclidotus fontinaloides* on larger boulders, which was more frequent than upstream sections. Hemlock water dropwort was occasional along river margins.

Plate 3.5 Representative image of survey section 10 on the River Deel, showing remnant pool habitat (facing downstream to Jack Garrett Bridge).

Section 11

Section 11 was located immediately upstream of Jack Garrett Bridge (Figure 2.2). The section was dominated by a shallow glide profile and was semi-dry at the time of survey. However, two large localised pools of standing water were present. Here, the depth averaged 0.1-0.5m. The river channel averaged 20m in width with a bank height of 2-3m. The section was dominated by cobble substrata (50%) with frequent very coarse gravel and roughly equal proportions of boulder, very coarse gravel and medium gravel. Fine gravel and sand was present but sparse (5% only). Soft sediment accumulations were absent.

The section offered some moderate salmonid holding habitat in pooling areas (Table 3.1), although these were shallow and of less value in comparison to further upstream. Nursery habitat was evidently good, with juvenile salmonids abundant in the pooling areas at the time of survey (numerous 0+ with small numbers of ≥1+ fish). Spawning habitat was considered to be of good value, locally. Nursery habitat for lamprey was poor (Table 3.2) given the absence of soft sediment areas. Lamprey spawning habitat was considered moderate, with some suitable smaller substrata scattered throughout. European eel habitat was considered moderate overall given the scarcity of suitable refugia compared with upstream sections.

Section 11 was adjoined by built land (BL3) on both banks and bound by retaining walls associated with Crossmolina town. Ornamental cherry (*Prunus* sp.) and privet (*Ligustrum* sp.) hedgerows were present on the east bank near the bridge. Riparian treelines located at the upstream extent of the section featured sycamore and ash with occasional willow and hawthorn. The riparian herbaceous layer comprised hemlock water dropwort, cow parsley, elder, ground elder, ivy, water figwort, nettle and bramble. Instream vegetation was limited to localised patches of *Cinclidotus fontinaloides* on larger boulders and the dry bridge apron. Filamentous algae was frequent in standing water pools. Hemlock water dropwort was occasional along river margins.

Section 12

Section 12 was located immediately downstream of Jack Garrett Bridge (Figure 2.2). The section was dominated by a shallow glide profile and was semi-dry at the time of survey. However, localised pools of standing water were present along the west bank. Here, the depth averaged 0.3-0.6m. The river channel averaged 15-18m in width with a variable bank height of 3-6m. The section was dominated by cobble (50%) and very coarse gravel (20%) substrata, with occasional boulder and coarse gravel, and lesser fractions of medium gravel, fine gravel and sand. Soft sediment accumulations were absent.

The section offered some good salmonid holding habitat in pooling areas (Table 3.1), although these were shallower and of less value in comparison to sections further upstream (e.g. section 9, 10). Nursery habitat was considered to be good during wetted periods. Low numbers of both juvenile and small adult salmonids were present in the pooling areas at the time of survey. Spawning habitat for both salmonids and lamprey was considered to be of moderate value only given relatively high compaction of substrata compared with further upstream sections. Nursery habitat for lamprey was poor (Table 3.2) given the absence of soft sediment areas. European eel habitat was considered moderate overall given the scarcity of suitable refugia compared with upstream sections.

Section 12 was adjoined by built land (BL3) on both banks and bound by retaining walls associated with Crossmolina town. Small areas of amenity grassland (GA2) were also present along the west bank. The riparian zones featured sparse, scrubby growth of mature grey willow on V-shaped banks with localised osier and sycamore. A herbaceous layer of cow parsley, nettle, great willowherb (*Epilobium hirsutum*), hemlock water dropwort, water figwort and butterbur was also present. Instream vegetation was limited to localised patches of *Cinclidotus fontinaloides* on larger boulders and the dry bridge apron. Hemlock water dropwort and common spike rush (*Eleocharis palustris*) was occasional along river margins (mostly east bank). Japanese knotweed was frequent along the east bank (historical control efforts evident). A regular otter spraint site, containing white-clawed crayfish fragments, was recorded under Jack Garrett Bridge.

Plate 3.6 Representative image of survey section 12 on the River Deel, facing downstream from Jack Garrett Bridge.

Section 13

Section 13 was located 0.1km downstream of Jack Garrett Bridge (Figure 2.2). The section was dominated by a shallow glide profile and was semi-dry at the time of survey. However, a large localised pool of standing water was present towards the downstream end of the section (and continued downstream, beyond the survey reach). Here, the depth ranged from 0.3 to >1.5m. The river channel averaged 12-15m in width with a variable bank height of 3-5m. The section was dominated by cobble (40%) and very coarse gravel (20%) substrata, with frequent boulder (20%) occasional coarse gravel and lesser fractions of medium gravel, fine gravel and sand. Soft sediment accumulations were absent.

The section offered some good salmonid holding habitat in pooling areas (Table 3.1), although this evidently improved further downstream of the meander. Nursery habitat was considered to be good during wetted periods. However, low numbers of both juvenile and small adult salmonids were present in the pooling area at the time of survey, along with minnow. Spawning habitat for

both salmonids and lamprey was considered to be of moderate value only given relatively high compaction of substrata compared with further upstream sections. Nursery habitat for lamprey was poor (Table 3.2) given the absence of soft sediment areas. European eel habitat was considered good overall given refugia associated with deeper pool habitat and more frequent boulders compared.

Section 13 was adjoined by built land (BL3) on both banks and bound by retaining walls associated with Crossmolina town. Small areas of amenity grassland (GA2) and improved agricultural grassland (GA1) was also present along the west bank. The riparian zones featured sparse, scrubby growth of mature grey willow on V-shaped banks with localised osier and sycamore. A herbaceous layer of cow parsley, nettle, great willowherb, hemlock water dropwort, water figwort and butterbur was also present. Instream vegetation was limited to localised patches of *Cinclidotus fontinaloides* on larger boulders. Hemlock water dropwort and common spike rush was occasional along river margins (mostly east bank). Japanese knotweed was frequent along the east bank (historical control efforts evident).

Plate 3.7 Representative image of survey section 13 on the River Deel, showing deep stagnant pool habitat.

3.3 Fisheries habitat

Salmonids

The overall salmonid habitat quality of the surveyed sections of the River Deel ranged from good to excellent based on Life Cycle Unit scores (Table 3.1). In general, the river offered good salmonid habitat throughout the 1.3km survey reach, with sections 2 and 8 offering excellent salmonid habitat, particularly given the presence of extensive deep pool areas (i.e. holding habitat). Holding habitat was typically good throughout although some glide profile-dominated sections featured

few deeper areas (considered retrospectively in respect of the river under normal flow conditions). Spawning habitat was considered good in all areas upstream of Crossmolina, with the two 100m sections surveyed downstream of Jack Garrett Bridge offering moderate spawning only. Overall, the Deel offered good nursery habitat when the river was considered during wetted periods.

Table 3.1 Summary of the salmonid Life Cycle Unit scores for the 13 No. 100m River Deel survey sections surveyed in May 2020.

Section	Salmonid habitat value	Spawning	Nursery	Holding	Total score	Salmonids observed
1	Good	2	2	2	**6**	Yes; trapped in pool
2	Excellent	2	2	1	**5**	No; channel 100% dry
3	Good	2	2	2	**6**	No; channel 100% dry
4	Good	2	3	2	**7**	No; channel 100% dry
5	Good	2	3	3	**8**	No; channel 100% dry
6	Good	2	3	2	**7**	No; channel 100% dry
7	Good	2	2	2	**6**	No; channel 100% dry
8	Excellent	2	2	1	**5**	Yes; trapped in pool
9	Good	2	2	2	**6**	Yes; trapped in pool
10	Good	2	2	2	**6**	Yes; trapped in pools
11	Good	2	3	3	**8**	Yes; trapped in pools
12	Good	3	2	2	**7**	Yes; trapped in pools
13	Good	3	2	2	**7**	Yes; trapped in pools

Lamprey

The overall habitat quality of the surveyed sections of the River Deel for *Lampetra* sp. ranged from poor to moderate based on Lamprey Habitat Quality Index (LHQI) scores (Table 3.2). Overall habitat quality for the larger sea lamprey (*Petromyzon marinus*) was improved (moderate to good overall; Table 3.3). Potential sea lamprey spawning habitat was more widespread compared to that required for smaller species such as brook lamprey (*Lampetra planeri*). Only sections 1, 2 and 9 offered potential for ammocoete burial, although this was highly localised in small marginal areas.

Table 3.2 Summary of the Lamprey Habitat Quality Index (LHQI) scores for ***Lampetra* sp. only** the 13 No. 100m River Deel survey sections surveyed in May 2020.

Section	Lamprey habitat value	Spawning	Nursery	Total score	Best larval habitat present
1	Moderate	4	3	**7**	Type 1 (optimal) - rare
2	Moderate	4	3	**7**	Type 1 (optimal) - rare
3	Poor	4	4	**8**	Type 3 (unsuitable)
4	Poor	4	4	**8**	Type 3 (unsuitable)
5	Moderate	3	4	**7**	Type 3 (unsuitable)
6	Moderate	3	4	**7**	Type 3 (unsuitable)
7	Moderate	3	4	**7**	Type 3 (unsuitable)
8	Moderate	3	4	**7**	Type 3 (unsuitable)
9	Moderate	3	3	**6**	Type 2 (sub-optimal) - rare
10	Moderate	3	4	**7**	Type 3 (unsuitable)
11	Moderate	3	4	**7**	Type 3 (unsuitable)
12	Poor	4	4	**8**	Type 3 (unsuitable)
13	Poor	4	4	**8**	Type 3 (unsuitable)

Table 3.3 Summary of the Lamprey Habitat Quality Index (LHQI) scores for **sea lamprey only** the 13 No. 100m River Deel survey sections surveyed in May 2020.

Section	Lamprey habitat value	Spawning	Nursery	Total score	Best larval habitat present
1	Good	2	3	**5**	Type 1 (optimal) - rare
2	Good	2	3	**5**	Type 1 (optimal) - rare
3	Moderate	2	4	**6**	Type 3 (unsuitable)
4	Moderate	2	4	**6**	Type 3 (unsuitable)
5	Moderate	2	4	**6**	Type 3 (unsuitable)
6	Moderate	2	4	**6**	Type 3 (unsuitable)
7	Moderate	2	4	**6**	Type 3 (unsuitable)
8	Moderate	2	4	**6**	Type 3 (unsuitable)
9	Good	2	3	**5**	Type 2 (sub-optimal) - rare
10	Moderate	2	4	**6**	Type 3 (unsuitable)
11	Moderate	2	4	**6**	Type 3 (unsuitable)
12	Moderate	3	4	**7**	Type 3 (unsuitable)
13	Moderate	3	4	**7**	Type 3 (unsuitable)

3.4 RHAT scores

In consideration of RHAT scores, the 1.3km length of River Deel channel surveyed was divided into 3 No. discreet blocks, i.e. section A (500m), section B (500m) and section C (300m). Sections A and B achieved RHAT hydromorph scores of 0.7, corresponding to WFD 'good status' (Table 3.4; Figure 3.1). These sections of river channel were largely natural (aside from being dry/semi-dry at the time of survey) in terms of their channel morphology, vegetation, substrata diversity, (lack of) barriers to continuity, bank structure and bank/bank top vegetation. In contrast, the lowermost section C, in the vicinity of Crossmolina, achieved a hydromorph score of 0.4, corresponding to a WFD 'poor' status. This was due to historical arterial drainage, bank works and infrastructure (flood walls) associated with an urban environment, which had affected channel

morphology, barriers to continuity, bank structure, bank top vegetation and riparian land use, in addition to a lack of floodplain connectivity.

Table 3.4 Summary of the RHAT scores for the 1.3km of River Deel channel surveyed in May 2020.

	500m river section		
Assessment criteria	**A**	**B**	**C**
Channel morphology & flow types	3	3	1
Channel vegetation	3	3	2
Substrate diversity & condition	2	3	3
Barriers to continuity	4	4	2
Bank structure & stability	3	3	1.5
Bank & bank top vegetation	3	3	1.5
Riparian land use	2.5	1	0.5
Floodplain interactions	2	2	0
Total	**22.5**	**22**	**11.5**
Hydromorph score	0.7	0.7	0.4
Corresponding WFD class	Good status	Good status	Poor status

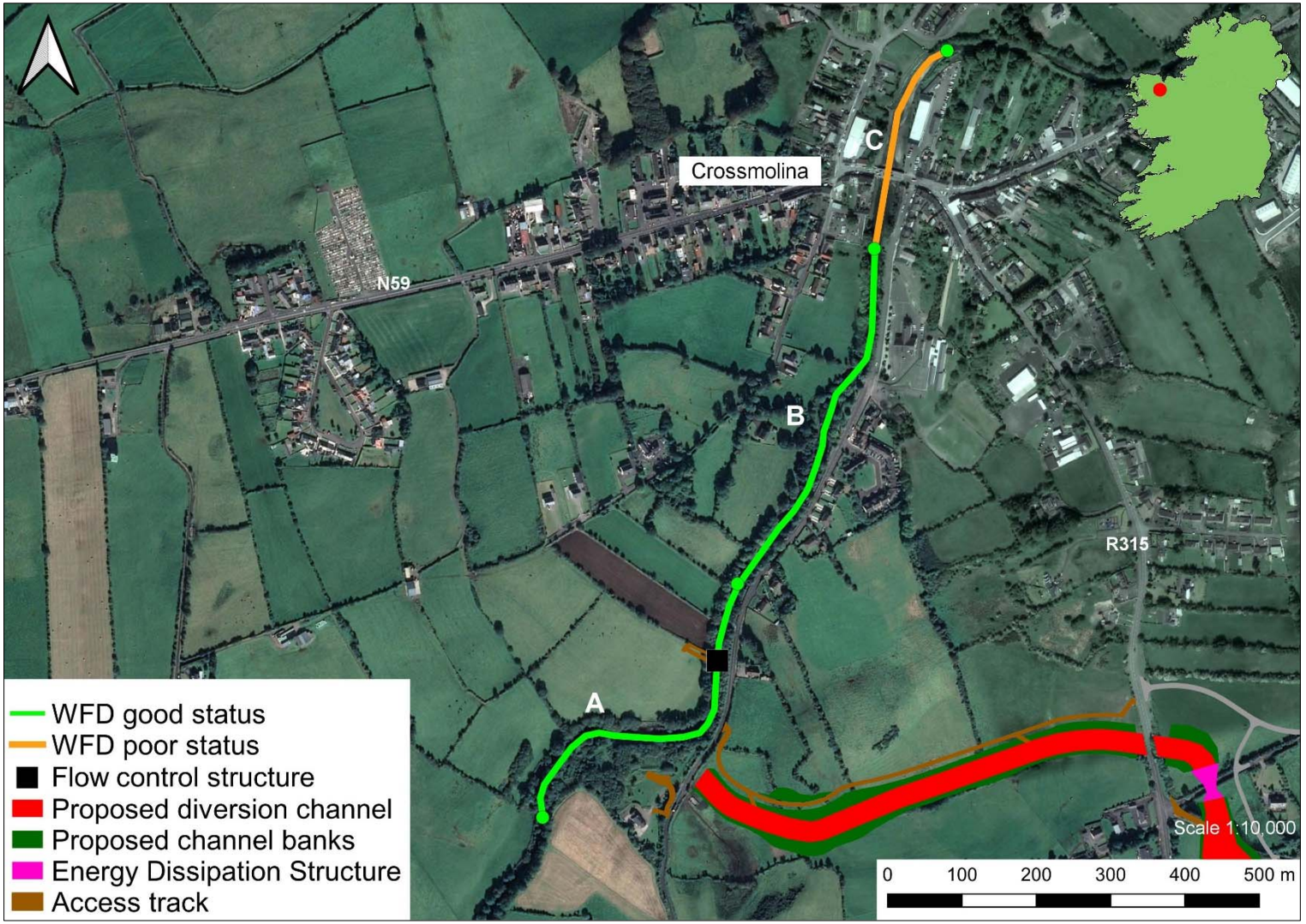

Figure 2.3 Corresponding WFD status for the 3 No. River Deel RHAT survey sections.

4. Discussion & recommendations

A fisheries appraisal was undertaken on a 1.3km length of the River Deel in the vicinity of Crossmolina on May 12th 2020. While the river channel was largely dry at the time of the survey, it allowed inspection of the riverbed substrata size classes. This helped identify the river's inherent fisheries value when considered in terms of normal flow regimes (i.e. naturally a swift flowing glide and pool spate channel). Under such normal flow conditions the River Deel supports an abundance of salmonids and other species. Indeed, even during the observed dry weather flows, the small pools of water remaining supported locally abundant juvenile salmonids (many observably 0+ age class), exemplifying the area's importance as a spawning and nursery habitat for salmonids. Taking full-flow periods into consideration, the river offered good salmonid habitat throughout the 1.3km survey reach, with sections 2 and 8 offering excellent overall salmonid habitat. Habitat was typically poorer downstream of Crossmolina, where historical works had altered the river channel (much lower RHAT scores, Table 3.4). Holding habitat for adult fish was typically good throughout the survey area, although some glide profile-dominated sections featured few deeper areas (these were more suitable as nursery areas). Salmonid spawning habitat was considered good and widespread in all areas upstream of Crossmolina with the more prolific adult salmonid spawning habitat being situated at the tailings of deeper pool areas. Spawning was considered less optimal downstream of Jack Garrett Bridge, albeit the area may still support spawning adult fish during peak runs. In terms of the location of the best spawning habitat, a particularly suitable spawning area of loose, small cobble/very coarse gravel was located immediately upstream of the deep pool area in section 9 (near the small meander/channel constriction). Overall, the Deel was considered to offer very good salmonid nursery habitat during wetted periods throughout the survey reaches (as supported by widespread 0+ salmonids in scattered remnant pools), with the best habitat located both upstream and c.300m downstream of the proposed instream flood control structure.

The overall habitat quality of the surveyed sections for *Lampetra* sp. (i.e. river/brook lamprey) ranged from poor to moderate (Table 3.3), with overall habitat quality for sea lamprey (*Petromyzon marinus)* improved given the predominance of larger substrata more suitable for spawning (moderate to good habitat overall; Table 3.4). In general, the river throughout the 1.3km survey reach offered very limited larval lamprey habitat given the paucity of soft sediment accumulations. Only sections 1, 2 and 9 offered potential for ammocoete burial, although this was highly localised in small marginal areas of sand-dominated soft sediment. Lamprey ammocoetes, regardless of species, require soft sediment in which to burrow, be it mud, sand, silt, clay or a matrix of all types, which is ≥5cm in depth (Maitland, 2003). No soft sediment areas were identified in the immediate vicinity of the proposed flood control structure or diversion channel works area.

Sea lamprey spawning potential was good throughout most survey sections (i.e. given the species preference for coarser gravels under cobble as described in more detail below), with spawning habitat for smaller *Lampetra* species considered moderate overall (i.e. typically less finer gravel fractions in study area). Both sea lamprey and *Lampetra* sp. are known from the River Deel upstream of Crossmolina (O'Connor, 2004). 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 (Igoe et al., 2004). Such habitat was widespread throughout the survey sections. Owing to their relatively small morphologies, *Lampetra* species (i.e. River & Brook species) require clean, fine gravels in which to dig their redds (Rooney et al., 2013; Aronsuu & Virkkala, 2014) although areas may also include fractions of sand, larger gravels, and cobble (Nika & Virbickas, 2010). The sediment particle size usually associated with *Lampetra* species is fine to coarse sands (0.2–1.4 mm) (Goodwin et al., 2008) and these were present locally in interstitial spaces throughout all survey sections but largely disguised by the overburden of coarser material. It is likely that, in addition to known upstream spawning areas, the survey area in the vicinity of Crossmolina may also support some localised spawning for lamprey species, albeit the paucity of burial habitat near to these areas would somewhat reduce the viability of spawning site selection by adults.

European eel nursery habitat was considered widespread in the survey area given the abundance of unbedded cobble that would offer viable refugia for maturing eel in addition to a crayfish and small fish prey base. The species has been recorded in fair numbers during the National Eel Monitoring Programme (2012-2014) downstream of Crossmolina (O' Leary et al. 2015).

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