

AtkinsRéalis



# Natura Impact Statement - Volume 2 (Appendices)

Uisce Éireann

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5161805DG0457

# Mortarstown Wastewater Treatment Plant Upgrade

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# APPENDICES

# Appendix A. Fisheries Assessment Reports

**A.1 September 2021 (Triturus, 2021)**

**A.2 August 2025 (Triturus, 2025)**



# Fisheries assessment of Mortarstown WWTP upgrade works, Co. Carlow



Prepared by Triturus Environmental Ltd. for Atkins

**September 2021**

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Triturus (2021). Fisheries assessment of Mortarstown WWTP upgrade works, Co. Carlow. Report prepared by Triturus Environmental Ltd. for Atkins. September 2021.

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## 1. Introduction

### 1.1 Background

Triturus Environmental Ltd. were contracted by Atkins to undertake a baseline fisheries assessment of the River Barrow in the vicinity of proposed upgrade works to Mortarstown Wastewater Treatment Plant (WWTP) (licence no. D0018-01) near Carlow Town, Co. Carlow (**Figure 2.1**).

The upgrades (see section 1.2 below) involve works to the riverbank of the River Barrow and within the channel of the Barrow in the vicinity of the proposed WWTP outfall chamber and outfall pipe. The proposed works area is located within the River Barrow and River Nore SAC (002162), a site designated for a range of aquatic qualifying interests including Atlantic salmon (*Salmo salar*) and lamprey species (NPWS, 2011). Given that the proposed project will require a cofferdam and dry instream working area, the proposed project has the potential to impact juvenile lamprey (ammocoetes) during the construction period, if they are present within the footprint of the instream working area (i.e., within soft sediment along river margins).

Therefore, the survey was undertaken to establish baseline fisheries data used in the preparation of the NIS for the proposed works. A bathymetric survey of the River Barrow was also undertaken within the wider works footprint to identify the presence of and evaluate the quality of lamprey habitat not accessible by electro-fishing operators (i.e., due to depth constraints). The electro-fishing and bathymetry survey on the River Barrow in vicinity of the proposed works area are summarised on **Table 2.1 & Figure 2.1**. Whilst the survey focused primarily on assessing value for lamprey ammocoetes, electro-fishing also provided baseline information on the general fisheries habitat and value of the area in vicinity of the proposed works. The surveyed helped to inform impact assessment and any subsequent mitigation for the project.

### 1.2 Proposed works description

#### 1.2.1 Mortarstown WWTP

The principal objective of the works associated with Mortarstown WWTP is to ensure that the treatment process can produce a treated effluent which satisfies the conditions of the Wastewater Discharge Licence (D0028-01). The works shall be designed to cater for 58,000 p.e. and achieve ELV's of 15 mg/L BOD, 35 mg/L SS, 2 mg/L Ammonia and 1 mg/L Total Phosphate.

The WWTP was commissioned in 1986 as a conventional extended aeration WWTP with a design capacity of 28,500PE. The aeration basins were upgraded in 2003 to a A2O bioreactor system (anaerobic, anoxic, aerobic) which provides an additional treatment capacity of 7,500PE in the bioreactors. Therefore, the WWTP had inadequate capacity to cater for future demand and much of the existing mechanical and electrical equipment is at end of serviceable life and is no longer functioning.

In addition, the Supervisory Control and Data Acquisition (SCADA) system is defunct and the systems for automatic control and measurement of the storm return and surplus sludge are not operational. The plant requires greater manual input than was originally intended.

As part of the upgrade works all flows to the WWTP will be subjected to preliminary treatment comprising coarse screening, fine screening, grit removal and storm water storage. Biological treatment for carbonaceous and nitrogen removal will be achieved by supplementing the existing activated sludge process with upstream primary treatment. Phosphorus removal will be achieved using a combination of biological and chemical treatment and all treated effluent will discharge by either gravity or pressure into the River Barrow.

A summary of the works required is as follows;

- Provision of 1 no. 540 kWh terminal pump station.
- Provision of 4 no. raw sewerage pumps inclusive of MEICA works.
- Provision of 1 no. odour control unit.
- Provision of 1 no. surge protection vessel.
- Provision of new inlet works to include coarse screening, fine screening and grit removal.
- Provision of 1 no. stormwater storage tank and 2 no. stormwater return pumps.
- Refurbishment of peripheral half-bridge scrapers in existing final settlement tanks.
- Refurbishment of RAS/WAS pumping station and provision of 2 No. stormwater return pumps.
- Provision of 4 no. primary settlement tanks and 4 No. chain and flight tank scraper systems.
- Provision of 4 no. primary sludge pumps.
- Provision of 5 no. air blowers and modifications to existing air delivery pipework.
- Provision of 2 no. final settlement tanks with half-bridge scrapers.
- Provision of new RAS/WAS pumping station and 2 No. (each) RAS/WAS pumps.
- Refurbishment of existing picket fence thickener and conversion to sludge blending tank.
- Provision of 1 no. additional picket fence thickener.
- Provision of 1 no. new centrifuge, polymer prep unit and polymer dosing pumps.
- Provision of 2 no. final effluent pumps.
- Provision of 1 no. new outfall chamber and outfall pipe.

### 1.3 Fisheries asset of the survey area

The River Barrow is Ireland's second-longest river, flowing for some 192km and draining an area of approx. 3010km<sup>2</sup> (Delanty et al., 2017). The main channel, estuary and many of the sub-catchments are located within the River Barrow and River Nore SAC (site code: 002162). The following fish and aquatic invertebrate species are listed as qualifying interest species for the SAC (NPWS, 2011);

- Freshwater pearl mussel (*Margaritifera margaritifera*) [1029]
- White-clawed crayfish (*Austropotamobius pallipes*) [1092]
- Sea lamprey (*Petromyzon marinus*) [1095]
- Brook lamprey (*Lampetra planeri*) [1096]

- River lamprey (*Lampetra fluviatilis*) [1099]
- Twait shad (*Alosa fallax*) [1103]
- Atlantic salmon (*Salmo salar*) (only in fresh water) [1106]
- Nore freshwater pearl mussel (*Margaritifera durrovensis*) (River Nore catchment only) [1990]
- Otter (*Lutra lutra*) [1355]

### 1.3.1 Lamprey species (Annex II)

All three of the lamprey species recorded in Ireland, brook (*Lampetra planeri*), river (*Lampetra fluviatilis*) and sea lamprey (*Petromyzon marinus*), are all listed on Annex II of the European Union (EU) Habitats Directive (92/43/EEC). Atypically for Ireland, all three species are known to occur in the River Barrow and are each listed as conservation objectives for the River Barrow and River Nore SAC (002162). All of these lamprey species are semelparous, i.e. breed once in their lifetimes and then die.

A dedicated catchment-wide lamprey survey (King, 2006) found that the River Barrow was poor in terms of ammocoete distribution, with a greater number of negative sites encountered than in other surveys of large Irish river catchments. Over 50% of sites did not contain juvenile lamprey and none were recorded on the main Barrow channel. Likewise, Delanty et al. (2017) found similar results, with over half the sites returning negative results (i.e. no ammocoetes) and none recorded in the main river channel. According to Inland Fisheries Ireland, sea lamprey favour the turbulent aerated sections of the river for spawning, areas that are now largely restricted to the tail race of weir structures along the River Barrow (IFI, 2011). Sea lamprey occupy a very limited distribution in the Barrow catchment and were historically known to spawn below the weirs at Graiguenamanagh, Tinnahinch, Bahana and, particularly, St. Mullins (Kurz & Costello, 1999; pers. obs.). The latter is accepted as being the last remaining important spawning site for the species in the Barrow. Population sizes are, however, accepted as typically being small on the main River Barrow channel (King, 2006).

The nearest good-quality lamprey habitat to the Mortarstown WWTP survey area was identified via electro-fishing surveys in 2018 immediately below Carlow Weir (1.6km upstream; Macklin et al., 2018), where relatively high densities of *Lampetra* sp. were recorded (i.e., > 30 per m<sup>2</sup>). A low density of *Lampetra* sp. ammocoetes (2.6 per m<sup>2</sup>) was also recorded on the Barrow at Clongrennan lock, approx. 1.6km downstream of the proposed works area, in September 2020 (Triturus, 2020).



## 2. Methodology

### 2.1 Fish stock assessment (electro-fishing)

Triturus Environmental Ltd. made an application under Section 14 of the Fisheries (Consolidation) Act, 1959 as substituted by Section 4 of the Fisheries (Amendment) Act, 1962, to undertake an electro-fishing survey in the footprint of the proposed Mortarstown WWTP upgrade works. Permission was granted on Friday 2<sup>nd</sup> July 2021 and the survey was undertaken on Thursday 15<sup>th</sup> July 2021, following notification to Inland Fisheries Ireland and under the conditions of a Department of Communications, Climate Action & Environment (DCCAE) licence. A single anode Smith-Root LR24 backpack (12V DC input; 300V, 100W DC output) was used to electro-fish the River Barrow in the footprint of the proposed Mortarstown WWTP upgrade works. Soft sediment areas within the vicinity of the proposed works area were evaluated in terms of their suitability for lamprey ammocoetes.

Both river and holding tank water temperature was monitored continually throughout the survey to ensure temperatures of 20°C were not exceeded, thus minimising stress to the captured fish due to low dissolved oxygen levels. A portable battery-powered aerator was also used to further reduce stress to any captured fish contained in the holding tank. Captured larval lamprey and other incidental fish species were transferred to a holding container with oxygenated fresh river water following capture. To reduce fish stress levels, anaesthesia was not applied to captured fish. All fish were measured to the nearest millimetre and released in-situ following a suitable recovery period. Electro-fishing methodology followed accepted European standards (CEN, 2003) and adhered to best practice (e.g. CFB, 2008).

The electro-fishing survey was undertaken at  $n=2$  sites within the vicinity of the proposed WWTP outfall works (**Table 2.1, Figure 2.1**).

**Table 2.1** Electro-fishing survey site locations in the vicinity the proposed Mortarstown WWTP upgrade works, Carlow

| Site no. | Watercourse  | EPA code | Location                                        | X (ITM) | Y (ITM) |
|----------|--------------|----------|-------------------------------------------------|---------|---------|
| A        | River Barrow | 14B01    | Near proposed Mortarstown WWTP outfall          | 671109  | 674928  |
| B        | River Barrow | 14B01    | Downstream of proposed Mortarstown WWTP outfall | 671077  | 674894  |

#### 2.1.1 Lamprey

Electro-fishing for lamprey ammocoetes was conducted using targeted quadrat-based electro-fishing (as per Harvey & Cowx, 2003) in objectively suitable areas of soft sediment, where encountered. As lamprey take longer to emerge from sediment and require a more persistent approach, they were targeted at a lower frequency (30Hz) burst DC pulse setting which also allowed the safe capture of European eel and other fish species, if present. Settings for lamprey followed those recommended and used by Harvey & Cowx (2003), APEM (2004) and Niven &

McAuley (2013). Using this approach, the anode was placed under the water's 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 were collected by a second operator using a fine-mesh hand net as they emerged. Lamprey species were identified to species level, where possible, with the assistance of a hand lens, through external pigmentation patterns and trunk myomere counts as described by Potter & Osborne (1975) and Gardiner (2003).

### 2.1.2 General fisheries habitat

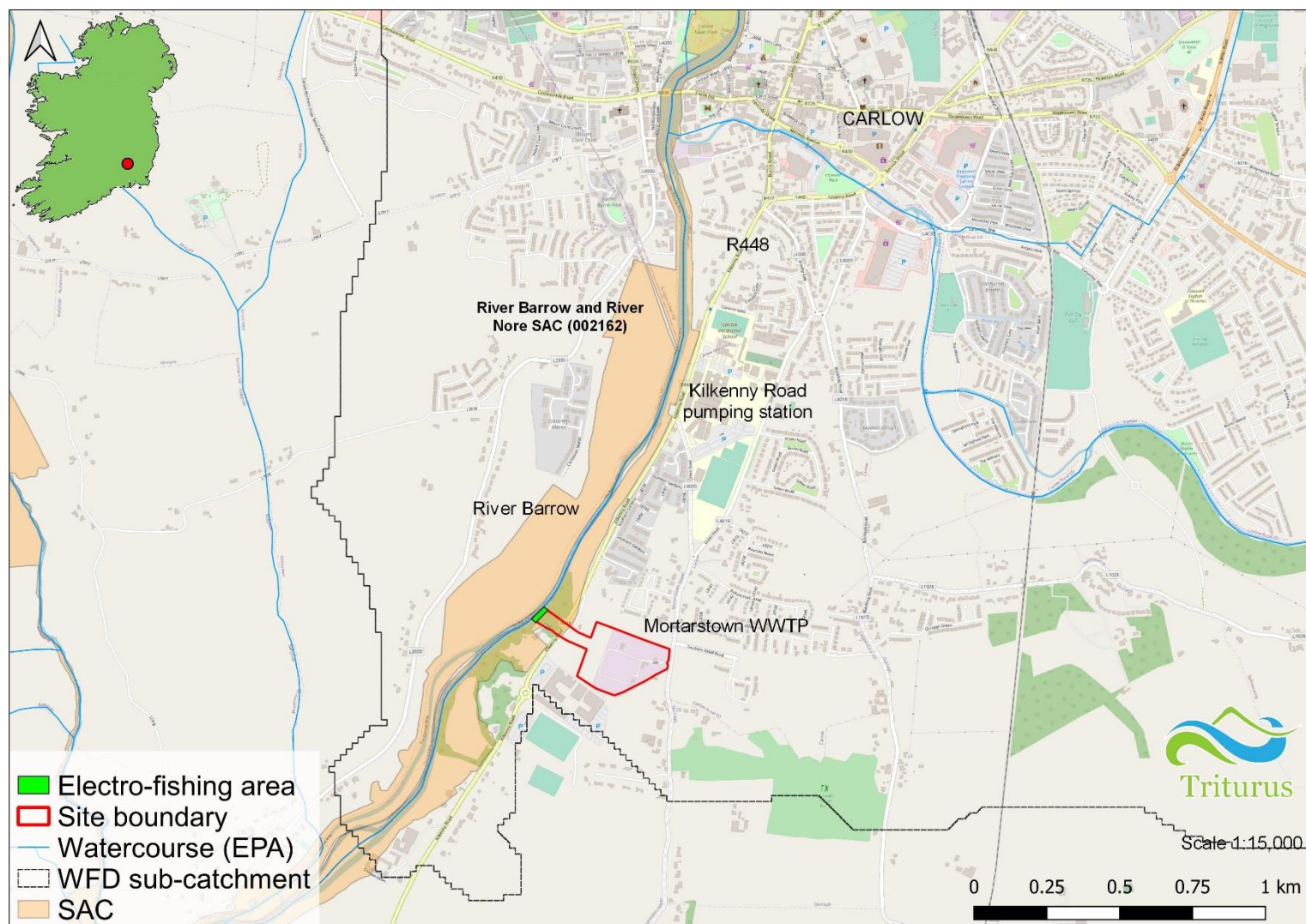
A broad appraisal of the upstream and downstream habitat in vicinity of the survey site was undertaken to evaluate the wider contribution to salmonid and lamprey spawning and general fisheries habitat. River habitat surveys and fisheries assessments were carried out utilising elements of the approaches in the River Habitat Survey Methodology (EA, 2003) and Fishery Assessment Methodology (O'Grady, 2006) to broadly characterise the survey area (i.e., channel profile, substrata etc.).

## 2.2 SONAR survey

To determine the bathymetry and substrata-type (i.e., bottom hardness) within the vicinity of the proposed WWTP outfall area, a SONAR survey was undertaken during July 2021. Primarily, this approach helped to estimate the extent of and elucidate any potential (soft sediment) larval lamprey areas that maybe present in poorly-accessible deeper water zones (i.e., >1.3m in depth, beyond scope of backpack electro-fishing). However, the survey also provided information on the wider fisheries habitat present in the vicinity of works area. A Lowrance Elite 9HDS-Live SONAR unit was mounted on a 3m RIB equipped with a total-scan transducer to log bathymetry and bottom hardness. Reefmaster v2.0 software was used to generate point clouds for map creation in QGIS v3.18.

## 2.3 Biosecurity

A strict biosecurity protocol including the Check-Clean-Dry approach was adhered to during surveys for all equipment and PPE used. Disinfection of all equipment and PPE before and after use with Virkon™ was conducted to prevent the transfer of pathogens or invasive propagules between survey sites. The outboard engine was an electric 56lb thrust engine (i.e. no impeller water cooling), thus minimising bilge water transfer associated with traditional outboard models. The engine, being small in size, was easy to clean in a barrel of Virkon before and after use to prevent the spread of invasive species and pathogens. Particular note was taken of the possibility of spreading crayfish plague (*Aphanomyces astaci*), known within the River Barrow since 2017 (NPWS, 2017, 2019).



**Figure 2.1** Location of the electro-fishing area in vicinity of the proposed Mortarstown WWTP upgrade works





**Figure 2.2** Location of the electro-fishing spot points A and B in vicinity of the proposed Mortarstown WWTP upgrade works

### 3. Results

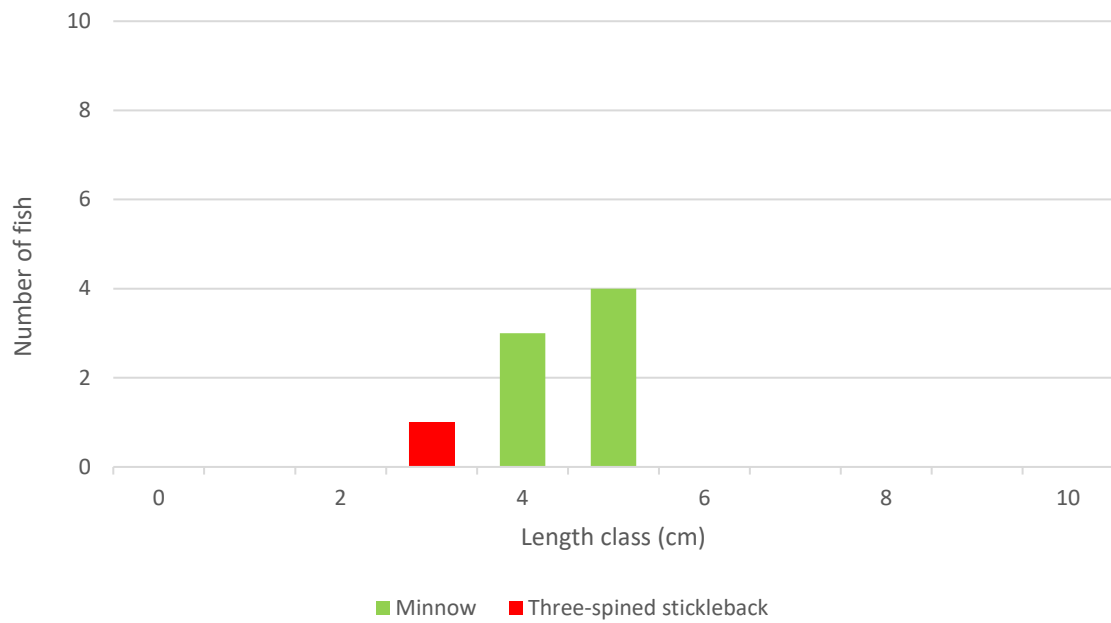
A targeted electro-fishing survey for lamprey ammocoetes was undertaken in the footprint of the proposed works on Wednesday 15<sup>th</sup> July 2021 following notification to Inland Fisheries Ireland. The results of the survey are discussed below in terms of fish population structure, population size and the suitability and value of the surveyed areas as nursery and spawning habitat for lamprey and other fish species. Scientific names are provided at first mention only.

#### 3.1 Fish stock assessment (electro-fishing)

##### 3.1.1 Site A (within proposed works area)

Site A was located on the east bank of the River Barrow, in the vicinity of the proposed outfall pipe works area (**Figure 2.2**). The river was a large lowland depositing watercourse (FW2; Fossitt, 2000) that averaged 30-35m wide and ranged from 1.2m deep in the margins to >3m in the central channel. The area was dominated by deep slow-flowing glide with localised area of deeper pool in the centre channel. The littoral area supported low flows and featured steeply-sloping banks of soft sediment (silt), which were invariably very deep (up to 0.3-0.4m) and near-anoxic in most areas. The littorals adjoined mixed coarse gravels with occasional cobble and boulder at the base of the marginal slope. The east bank of the river supported dense overhanging grey willow (*Salix cinerea*), crack willow (*Salix fragilis*) and osier (*Salix viminalis*). Riparian shading was high and this resulted in only limited macrophyte growth along the margins of the channel. Occasional submerged arrowhead (*Sagittaria sagittifolia*) was present in addition to non-native Nuttall's pondweed (*Elodea nuttallii*) recorded as rare.

Minnow (*Phoxinus phoxinus*) and three-spined stickleback (*Gasterosteus aculeatus*) were the only fish species recorded via electro-fishing from site A that was situated in the footprint of the proposed outfall area (**Figure 3.1**). Despite the presence of abundant, organic-rich soft sediment areas, no lamprey ammocoetes were recorded from targeted electro-fishing of 3 no. contiguous 1m<sup>2</sup> areas. Dense overhanging growth of willow species had resulted in little to no flows along the river margins and very heavy shading thus creating conditions inimical to larval lamprey. The site, however, had some value as a coarse fish nursery habitat.



**Figure 3.1** Length frequency distribution recorded via electro-fishing at site A on the River Barrow, July 2021



**Plate 3.1** Electro-fishing soft sediment littorals at site A for lamprey ammocoetes, July 2021





**Plate 3.2** Snorkelling the River Barrow margins between survey sites A and B to further evaluate lamprey habitat quality, July 2021



**Plate 3.3** Minnow recorded from site A, July 2021

### 3.1.2 Site B (downstream of proposed works area)

Site B was located in a small bay on the east bank of the River Barrow, approx. 30m downstream of the proposed outfall pipe works area (**Figure 2.2**). The site represented one of the few areas accessible to backpack electro-fishing in the vicinity of the proposed outfall works (i.e., <1.3m in depth). As per upstream, the river depths ranged from 1.2-1.3m in the margins to >3m in the central channel. The area was dominated by deep slow-flowing glide with localised area of deeper pool in the centre channel. The marginal substrata were dominated by organic-rich silt and sand (up to 0.2m in depth), grading into mixed gravels and occasional cobble and boulder at the base of the steep marginal slope. The site adjoined a residential property garden (GA2) and was more open than site A (historical tree clearance), with lower cover of overhanging trees. Thus, the area received some influence from currents, given the absence of overhanging trees and limbs which would otherwise restrict flow. Macrophytes were limited to occasional submerged arrowhead, with emergent water mint (*Mentha aquatica*) and reed canary grass (*Phalaris arundinacea*) along channel margins.

Minnow and *Lampetra* sp. ammocoetes were the only fish species recorded from site B via electro-fishing (**Figure 3.2**). In addition to low numbers of minnow, very low densities of *Lampetra* sp. ammocoetes were recorded, equating to a density of 1 per m<sup>2</sup> of targeted habitat fished. The increased marginal flows and reduced riparian shading compared with site A provided improved ammocoete habitat. However, this was still considered sub-optimal given the narrow extent of the burial habitat at the top of the littoral zone. The site was of most value as a coarse fish nursery habitat.



**Figure 3.2** Length frequency distribution recorded via electro-fishing at site B on the River Barrow, July 2021





**Plate 3.4** Representative image of site B on the River Barrow, July 2021 (located immediately downstream of the proposed outfall works area)



**Plate 3.5** *Lampetra* sp. ammocoete recorded from site B (downstream of the proposed outfall works area), July 2021

## 3.2 Bathymetric (SONAR) survey

### 3.2.1 Bathymetry

The SONAR survey confirmed the high average mean depth of the River Barrow ( $2.4\text{m} \pm 0.54\text{m}$  SD) in vicinity of the proposed outfall works area (**Figure 3.4**). As illustrated in Figure 3.3, the River Barrow follows a typical trapezoidal profile, with shallow margins steeply grading into a deeper centre channel of  $>3\text{m}$ . The minimum depth logged along the proposed works area (east bank) was  $1.5\text{m}$ , although instream wading of marginal areas not accessibly by boat revealed a typical depth of approx.  $1.2\text{m}$  under the overhanging willow canopy on a steeply-sloping river margin.

### 3.2.2 Bottom (substrate) hardness

The plot of bottom (substrate) hardness (**Figure 3.4**) shows a mixture of both soft and harder substrata (gravels, cobble, occasional boulder) in the footprint of the proposed works area. The areas of softer sediment (lighter shading) were restricted to the depositing channel margins along the east bank (that are covered by an extensive willow canopy and limbs that encourage deposition). While this habitat can support lamprey ammocoetes (chosen for burial by juveniles), snorkelling and electro-fishing carried out by wading the margins confirmed the near-anoxic soft sediment in this area was invariably deep (up to  $0.4\text{m}$  in depth) with very limited aeration due to restricted flow. A narrow band of soft sediment was also present along the east bank downstream of the proposed works area (i.e., in site B). However, the depth was shallower (maximum of  $0.2\text{m}$ ) given less deposition with well-mixed sand, silt and organic matter visibly lighter in colour, indicating greater oxygenation due to higher flow rates. This area was situated outside the main bathymetric study area but the pattern of softer substrata can be seen in the south western proportion of the sounding plot on **Figure 3.4**.



**Figure 3.3** Bathymetry map of the proposed Mortarstown WWTP outfall works area, July 2021 (darker shading indicates deeper water)





**Figure 3.4** Bottom hardness map of the proposed Mortarstown WWTP outfall works area, July 2021 (lighter shading indicates softer substrata)

## 4. Discussion

There was no suitability for lamprey ammocoetes within the proposed Mortarstown WWTP outfall works area (site A) despite the presence of soft substrata that could support lamprey ammocoetes (Figure 3.4 results). The soft sediment overlapping the proposed works area was considered unsuitable for lamprey ammocoetes, given high shading, poorly-oxygenated sediment and poor flow rates (refer to section 3.2.2 of results). Some peripheral, sub-optimal ammocoete habitat (site B) existed a short distance downstream of the proposed outfall area and a very low density (1 per m<sup>2</sup>) of *Lampetra* sp. ammocoetes was recorded via electro-fishing. The recorded density at site B was significantly lower than densities recorded downstream of Carlow Weir 1.6km upstream of the study area where >30 lamprey ammocoetes per m<sup>2</sup> were recorded in 2018 (Macklin et al., 2018). However, overall, the area of river channel in vicinity of the proposed works were of low value to lamprey in terms of both spawning (no value) and nursery habitat (sub-optimal). In this respect, lamprey ammocoetes require the deposition of fine, organic-rich sediment ≥5cm in depth in which to burrow and mature (Gardiner, 2003; Goodwin et al., 2008; Aronsuu & Virkkala, 2014). Furthermore, their survival depends on a permanent unidirectional water flow, to supply them with the proper nutrients, while promoting the exchange of respiratory gases and metabolic residues (Hardisty & Potter 1971; Ferreira et al., 2013). The narrow band of soft sediment areas along the east bank of the River Barrow within the vicinity of proposed works area supported very low flows given high riparian shading from willow trees and limbs, thus encouraging more anoxic sediments. Evidently, this resulted in conditions inimical to larval lamprey (none recorded via electro-fishing). Site B, located approx. 30m downstream of the proposed works area, was a more open habitat with higher flows and mixed silt, sand and organics. Consequently, this area supported more favourable conditions for lamprey (i.e., organic-rich, better-oxygenated soft sediment). While conditions were improved at site B, the area only supported a very low density of *Lampetra* sp. ammocoetes at 1 larva per m<sup>2</sup> of soft sediment habitat. The low density is considered resultant of low flow rates and poor mixing of currents (albeit better conditions than site A). No finer well oxygenated gravels were present in the vicinity of the study area, indicating an absence of suitable spawning areas near or adjoining soft sediment burial habitat.

Although it is becoming more widely accepted that larval lamprey may burrow at greater depths than previously thought (up to 1.5m), the optimal nursery water depth for *Lampetra* species (i.e., brook and river lamprey) is <1m and often <0.5m (Maitland, 2003). The SONAR survey confirmed that more optimal depths (i.e. <1m) are largely absent from the vicinity of the proposed outfall (Figure 3.3). *Lampetra* sp. ammocoetes in particular are known to prefer soft sediment areas with gradients no greater than 1% (Kelly & King, 2001). The marginal slopes of both the survey area, and much of the main channel of the River Barrow, are typically much steeper than this (Macklin et al., 2018; Triturus, 2017; pers. obs.) and are, thus, largely unsuitable for ammocoete settlement and burial. The exceptions being downstream of weirs and canal locks in addition to the confluence points of small tributaries and drains.

In support of previous findings on the River Barrow (King, 2006; Delanty et al., 2017; Triturus, 2017), lamprey spawning and ammocoete habitat was highly localised and limited in extent within the vicinity of the works area. Overall, the main channel of the River Barrow provides typically

poor habitat for lamprey (Delanty et al., 2017) given the predominance of deep, slow-flowing glide with steep margins. As stated previously, the nearest good-quality lamprey habitat to the Mortarstown WWTP survey area was identified via electro-fishing surveys in 2018 immediately below Carlow Weir (1.6km upstream), where relatively high densities of *Lampetra* sp. were recorded (i.e., > 30 per m<sup>2</sup>). A low density of *Lampetra* sp. ammocoetes (2.6 per m<sup>2</sup>) was also recorded on the Barrow at Clongrennan lock, approx. 1.6km downstream of the proposed works area, in September 2020 (Triturus, 2020).

Whilst of low value for lamprey, the wider survey Mortarstown WWTP outfall area was of value as a coarse fish habitat. The deep margins and overhanging tree canopies along the east bank of the River Barrow (i.e., proposed works area) provided good cover and nursery habitat for a range of species such as perch (*Perca fluviatilis*), dace (*Leuciscus leuciscus*) and roach (*Rutilus rutilus*). The adjoining deeper central channel (up to >3m) also provided good-quality coarse fish habitat for roach, dace, bream (*Abramis brama*) and bream hybrids, as well as adult pike (*Esox lucius*). This deeper glide was not considered to be of high value for adult salmonids (as holding habitat) or juveniles, given slow flow rates and a more homogenous profile. Better holding habitat exists in the faster flowing deep glide and pool downstream of Carlow Weir for approximately 250m. Good quality salmonid habitat also exist for juvenile salmonids (i.e., faster-flowing areas of riffle, supporting more varied cobble and boulder substrata) also exists downstream of Carlow Weir. The flows at Carlow weir also provide spawning for salmon where mixed cobble, coarse and medium gravels provide spawning opportunities in pool tailings. Further good-quality nursery, spawning and holding habitat is also present downstream, near Clongrennan Lock. In recent years, these areas were found to support moderate numbers of Atlantic salmon parr and low numbers of brown trout (Macklin et al., 2018; Triturus, 2020). On the main channel of the River Barrow outside of its tributaries, the best quality salmonid and lamprey habitat is found in the downstream vicinity of weirs, where flow rates are naturally higher (King, 2006; Delanty et al., 2017; pers. obs.).



## 5. References

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# Fisheries assessment of Mortarstown WWTP upgrade works, Co. Carlow



Prepared by Triturus Environmental Ltd. for Atkins Realis

**August 2025**

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## 1. Introduction

### 1.1 Background

Triturus Environmental Ltd. were contracted by Atkins-Realis to undertake a baseline fisheries assessment of the River Barrow in the vicinity of proposed upgrade works to Mortarstown Wastewater Treatment Plant (WWTP) (licence no. D0018-01) near Carlow Town, Co. Carlow (**Figure 2.1**).

The upgrades (see section 1.2 below) involve works to the riverbank of the River Barrow and within the channel of the Barrow in the vicinity of the proposed WWTP outfall chamber and outfall pipe. The proposed works area is located within the River Barrow and River Nore SAC (002162), a site designated for a range of aquatic qualifying interests including Atlantic salmon (*Salmo salar*) and lamprey species (NPWS, 2011). Given that the proposed project will require a cofferdam and dry instream working area, the proposed project has the potential to impact juvenile lamprey (ammocoetes) during the construction period, if they are present within the footprint of the instream working area (i.e., within soft sediment along river margins).

Therefore, the survey was undertaken to establish baseline fisheries data used in the preparation of the NIS for the proposed works. A bathymetric survey of the River Barrow was also undertaken within the wider works footprint to identify the presence of and evaluate the quality of lamprey habitat not accessible by electro-fishing operators (i.e., due to depth constraints). The electro-fishing and bathymetry survey on the River Barrow in vicinity of the proposed works area are summarised on **Table 2.1 & Figure 2.1**. Whilst the survey focused primarily on assessing value for lamprey ammocoetes, electro-fishing also provided baseline information on the general fisheries habitat and value of the area in vicinity of the proposed works. The current survey (July 2025) helped to inform impact assessment and any subsequent mitigation for the project by updating the previous survey conducted during July 2021. This aimed to contemporise the data in line with CIEEM best practice (CIEEM, 2019). This was considered given the study area supports mobile species (i.e. lamprey) that have the potential to change distributions within the study area resultant of habitat condition and the stochastic patterns of larval lamprey settlement in dynamic river environments. This included an assessment of the quality and distribution of supporting soft sediment nursery and associated flow conditions from observational data.

### 1.2 Proposed works description

#### 1.2.1 Mortarstown WWTP

The principal objective of the works associated with Mortarstown WWTP is to ensure that the treatment process can produce a treated effluent which satisfies the conditions of the Wastewater Discharge Licence (D0028-01). The works shall be designed to cater for 58,500 p.e. for the design horizon year 2047 and achieve ELV's of 25 mg/L BOD, 35 mg/L SS, 1.2 mg/L Ammonia and 1 mg/L Total Phosphate.

The WWTP was commissioned in 1986 as a conventional extended aeration WWTP with a design

capacity of 28,500PE. The aeration basins were upgraded in 2003 to a A2O bioreactor system (anaerobic, anoxic, aerobic) which provides an additional treatment capacity of 7,500PE in the bioreactors. Therefore, the WWTP had inadequate capacity to cater for future demand and much of the existing mechanical and electrical equipment is at end of serviceable life and is no longer functioning.

In addition, the Supervisory Control and Data Acquisition (SCADA) system is defunct and the systems for automatic control and measurement of the storm return and surplus sludge are not operational. The plant requires greater manual input than was originally intended.

As part of the upgrade works all flows to the WWTP will be subjected to preliminary treatment comprising fine screening, grit removal and storm water storage. Biological treatment for carbonaceous and nitrogen removal will be achieved by supplementing the existing activated sludge process with upstream primary treatment. Phosphorus removal will be achieved using a combination of biological and chemical treatment and all treated effluent will discharge by either gravity into the River Barrow.

A summary of the works required is as follows;

#### Mortarstown WWTP

- Provision of foul pumping station for local agglomeration adjacent to existing inlet works (supplemented by standby generator)
- Provision of a fuel storage tank and standby diesel generator to service the WWTP.
- Provision of new inlet works to include fine screening, mechanically raked by-pass screen, screening compaction and conveyance to skips, grit removal, grit classification and conveyance to skips. The new inlet works to be provided with an odour treatment unit.
- Provision of 2 no. stormwater storage tanks and 2 no. stormwater return pumps.
- Existing final settlement tanks and associated RAS/WAS to be retained, cleaned and decommissioned.
- Provision of 4 no. primary settlement tanks and scraper systems.
- Provision of 4 no. primary sludge pumps.
- Provision of 4 no. air blowers and modifications to existing air delivery pipework
- Provision of new air blower building.
- Provision of new fine bubble diffused air system in existing aeration tanks.
- Provision of 2 no. final settlement tanks with half-bridge scrapers.
- Provision of new RAS/WAS pumping station and station fitted with 2 no. RAS pumps and 2 no. WAS pumps.
- Structural refurbishment of picket fence tanks.
- Mechanical and electrical refurbishment of existing picket fence thickener and conversion of second existing tank to a sludge blending tank.
- Provision of 2 no. additional picket fence tank thickener.
- Provision of 1 no. belt press, polymer prep unit and polymer dosing pumps.
- Provision of new pumped sludge transfer system.

- Provision of sludge import facility.
- Provision of 1 no. new outfall chamber and outfall pipe.
- Modifications to existing administration building.
- Provision of MEICA and SCADA upgrades.
- New storage shed and associated gantry.
- Demolition of existing inlet works structure.
- Existing service relocations.
- General civil site works.

#### Microtunnel Gravity Sewer

- Provision of 775m microtunnel gravity sewer (Ø1650mm internal diameter) from the south side of the existing Kilkenny Road Pumping Station to the wet well of the new pumping station to be constructed adjacent the new inlet works of the upgraded WwTP. The microtunnel will be routed along the R448 Kilkenny Road before it traverses agricultural land to connect to the WwTP.
- The microtunnel comprises an interception manhole, 2 no. launch shafts and 2 no. reception shafts where the main launching facilities is proposed at the main PS shaft in the WwTP area.

#### New Wastewater Pumping Station

- Provision of 1 no. terminal pump station.
- Provision of 4 no. raw sewerage pumps inclusive of MEICA works.
- Provision of 1 no. standby generator and associated fuel storage.
- Provision of 1 no. odour control unit.
- Provision of 1 no. flow meter chamber

### **1.3 Fisheries asset of the survey area**

The River Barrow is Ireland's second-longest river, flowing for some 192km and draining an area of approx. 3010km<sup>2</sup> (Delanty et al., 2017). The main channel, estuary and many of the sub-catchments are located within the River Barrow and River Nore SAC (site code: 002162). The following fish and aquatic invertebrate species are listed as qualifying interest species for the SAC (NPWS, 2025);

- Freshwater pearl mussel (*Margaritifera margaritifera*) [1029]
- White-clawed crayfish (*Austropotamobius pallipes*) [1092]
- Sea lamprey (*Petromyzon marinus*) [1095]
- Brook lamprey (*Lampetra planeri*) [1096]
- River lamprey (*Lampetra fluviatilis*) [1099]
- Twait shad (*Alosa fallax*) [1103]
- Atlantic salmon (*Salmo salar*) (only in fresh water) [1106]

### 1.3.1 Lamprey species (Annex II)

All three of the lamprey species recorded in Ireland, brook (*Lampetra planeri*), river (*Lampetra fluviatilis*) and sea lamprey (*Petromyzon marinus*), are all listed on Annex II of the European Union (EU) Habitats Directive (92/43/EEC). Atypically for Ireland, all three species are known to occur in the River Barrow and are each listed as conservation objectives for the River Barrow and River Nore SAC (002162). All Irish lamprey species are semelparous, i.e. breed once in their lifetimes and then die.

A dedicated catchment-wide lamprey survey (King, 2006) found that the River Barrow was poor in terms of ammocoete distribution, with a greater number of negative sites encountered than in other surveys of large Irish river catchments. Over 50% of sites did not contain juvenile lamprey and none were recorded on the main Barrow channel. Likewise, Delanty et al. (2017) found similar results, with over half the sites returning negative results (i.e. no ammocoetes) and none recorded in the main river channel. According to Inland Fisheries Ireland, sea lamprey favour the turbulent aerated sections of the river for spawning, areas that are now largely restricted to the tail race of weir structures along the River Barrow (IFI, 2011). Sea lamprey occupy a very limited distribution in the Barrow catchment and were historically known to spawn below the weirs at Graiguenamanagh, Tinnahinch, Bahana and, particularly, St. Mullins (Kurz & Costello, 1999; pers. obs.). The latter is accepted as being the last remaining important spawning site for the species in the Barrow. Population sizes are, however, accepted as typically being small on the main River Barrow channel (King, 2006).

The nearest good-quality lamprey habitat to the Mortarstown WWTP survey area was identified via electro-fishing surveys in 2018 immediately below Carlow Weir (1.6km upstream; Macklin et al., 2018), where relatively high densities of *Lampetra* sp. were recorded (i.e., > 30 per m<sup>2</sup>). A low density of *Lampetra* sp. ammocoetes (2.6 per m<sup>2</sup>) was also recorded on the Barrow at Clongrennan lock, approx. 1.6km downstream of the proposed works area, in September 2020 (Triturus, 2020). The previous survey of the Mortarstown study area carried out by Triturus Environmental in July 2021 recorded low densities of larval lamprey, minnow and three-spined stickleback in the survey area (Triturus, 2021).

## 2. Methodology

### 2.1 Fisheries assessment (electro-fishing)

Triturus Environmental Ltd. made an application under Section 14 of the Fisheries (Consolidation) Act, 1959 as substituted by Section 4 of the Fisheries (Amendment) Act, 1962, to undertake an electro-fishing survey in the footprint of the proposed Mortarstown WWTP upgrade works. Permission was granted in June 2025 and the survey was undertaken on the 3<sup>rd</sup> of July 2025, following notification to Inland Fisheries Ireland and under the conditions of a Department of Climate, Energy & Environment (DCEE) licence. A single anode Smith-Root LR24 backpack (12V DC input; 300V, 100W DC output) was used to electro-fish the River Barrow in the footprint of the proposed Mortarstown WWTP upgrade works. Soft sediment areas within the vicinity of the proposed works area were evaluated in terms of their suitability for lamprey ammocoetes.

Both river and holding tank water temperature was monitored continually throughout the survey to ensure temperatures of 20°C were not exceeded, thus minimising stress to the captured fish due to low dissolved oxygen levels. A portable battery-powered aerator was also used to further reduce stress to any captured fish contained in the holding tank. Captured larval lamprey and other incidental fish species were transferred to a holding container with oxygenated fresh river water following capture. To reduce fish stress levels, anaesthesia was not applied to captured fish. All fish were measured to the nearest millimetre and released in-situ following a suitable recovery period. Electro-fishing methodology followed accepted European standards (CEN, 2003) and adhered to best practice (e.g. CFB, 2008).

The electro-fishing survey was undertaken at  $n=2$  sites within the vicinity of the proposed WWTP outfall works (**Table 2.1, Figure 2.1**).

**Table 2.1** Electro-fishing survey site locations in the vicinity the proposed Mortarstown WWTP upgrade works, Carlow

| Site no. | Watercourse  | EPA code | Location                                        | X (ITM) | Y (ITM) |
|----------|--------------|----------|-------------------------------------------------|---------|---------|
| A        | River Barrow | 14B01    | Near proposed Mortarstown WWTP outfall          | 671109  | 674928  |
| B        | River Barrow | 14B01    | Downstream of proposed Mortarstown WWTP outfall | 671077  | 674894  |

#### 2.1.1 Lamprey

Electro-fishing for lamprey ammocoetes was conducted using targeted quadrat-based electro-fishing (as per Harvey & Cowx, 2003) in objectively suitable areas of soft sediment, where encountered. As lamprey take longer to emerge from sediment and require a more persistent approach, they were targeted at a lower frequency (30Hz) burst DC pulse setting which also allowed the safe capture of European eel and other fish species, if present. Settings for lamprey followed those recommended and used by Harvey & Cowx (2003), APEM (2004) and Niven & McAuley (2013). Using this approach, the anode was placed under the water's 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 were collected by a second operator using a fine-mesh hand net as they emerged. Lamprey species were identified to species level, where possible, with the assistance of a hand lens, through external pigmentation patterns and trunk myomere counts as described by Potter & Osborne (1975) and Gardiner (2003).

### 2.1.2 Fisheries habitat

A fisheries habitat appraisal upstream and downstream of the survey area was undertaken to establish the importance for salmonid, lamprey, European eel and other fish species. The appraisals of salmonids and lamprey were cognisant of species-specific habitat requirements and preferences as outlined in O’Grady (2006), Hendry et al. (2003), Armstrong et al. (2003), Harvey & Cowx (2003), Maitland (2003) and Hendry & Cragg-Hine (1997). River habitat surveys and fisheries assessments were also carried out utilising elements of the approaches in the River Habitat Survey Methodology (EA, 2003) and Fishery Assessment Methodology (O’Grady, 2006) to broadly characterise the riverine sites (i.e. channel profile, substrata etc.).

## 2.2 SONAR survey

To determine the bathymetry and substrata-type (i.e., bottom hardness) within the vicinity of the proposed WWTP outfall area, a SONAR survey was undertaken during July 2025, repeating the previous July 2021 survey effort to examine the soft sediment distributions. Primarily, this approach helped to estimate the extent of and elucidate any potential (soft sediment) larval lamprey areas that maybe present in poorly accessible deeper water zones (i.e., >1.3m in depth, beyond scope of backpack electro-fishing). However, the survey also provided information on the wider fisheries habitat present in the vicinity of works area. A Hummingbird Xplore 9 unit was mounted on a 3m RIB equipped with a total-scan transducer to log bathymetry and bottom hardness. Reefmaster v2.0 software was used to generate point clouds for map creation in QGIS.

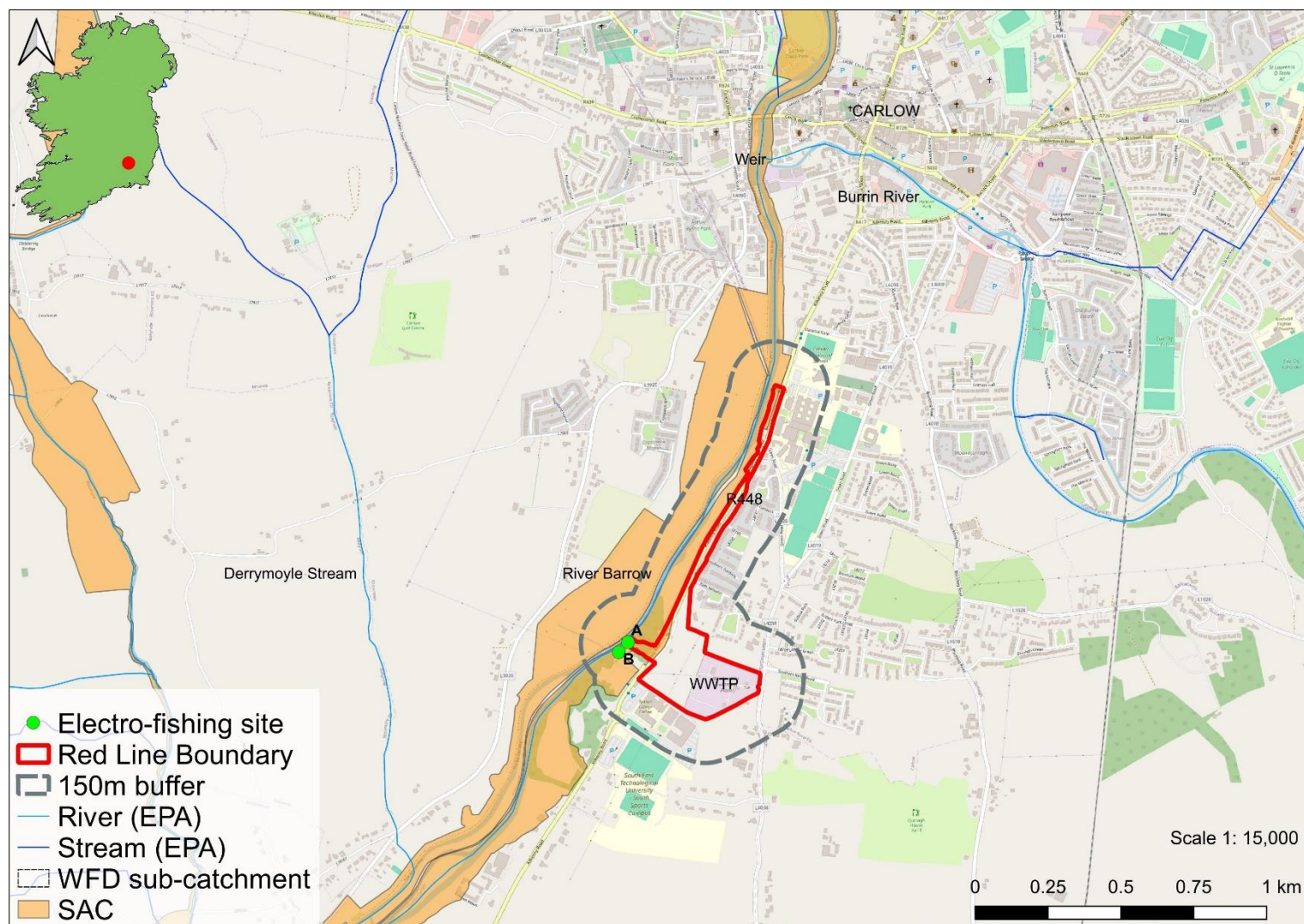
## 2.3 Biosecurity

A strict biosecurity protocol including the Check-Clean-Dry approach was adhered to during surveys for all equipment and PPE used. Disinfection of all equipment and PPE before and after use with Virkon™ was conducted to prevent the transfer of pathogens or invasive propagules between survey sites. The outboard engine was a Torqeedo electric engine (i.e. no impeller water cooling), thus minimising bilge water transfer associated with traditional outboard models (**Plate 2.1**). The engine, being light, was easy to clean in a barrel of Virkon before and after use to prevent the spread of invasive species and pathogens. Particular note was taken of the possibility of spreading crayfish plague (*Aphanomyces astaci*), known within the River Barrow since 2017 (NPWS, 2017, 2019).





**Plate 2.1** Survey equipment used during the July 2025 survey



**Figure 2.1** Location of the electro-fishing area in vicinity of the proposed Mortarstown WWTP upgrade works





**Figure 2.2** Location of the electro-fishing spot points A and B in vicinity of the proposed Mortarstown WWTP upgrade works

### 3. Results

A targeted electro-fishing survey for lamprey ammocoetes was undertaken in the footprint of the proposed works on the 3<sup>rd</sup> of July 2025 following notification to Inland Fisheries Ireland. This survey repeated that carried out in July 2021 to establish potential changes in the habitat structure and fish composition. The results of the survey are discussed below in terms of fish population structure, population size and the suitability and value of the surveyed areas as nursery and spawning habitat for lamprey and other fish species. Scientific names are provided at first mention only.

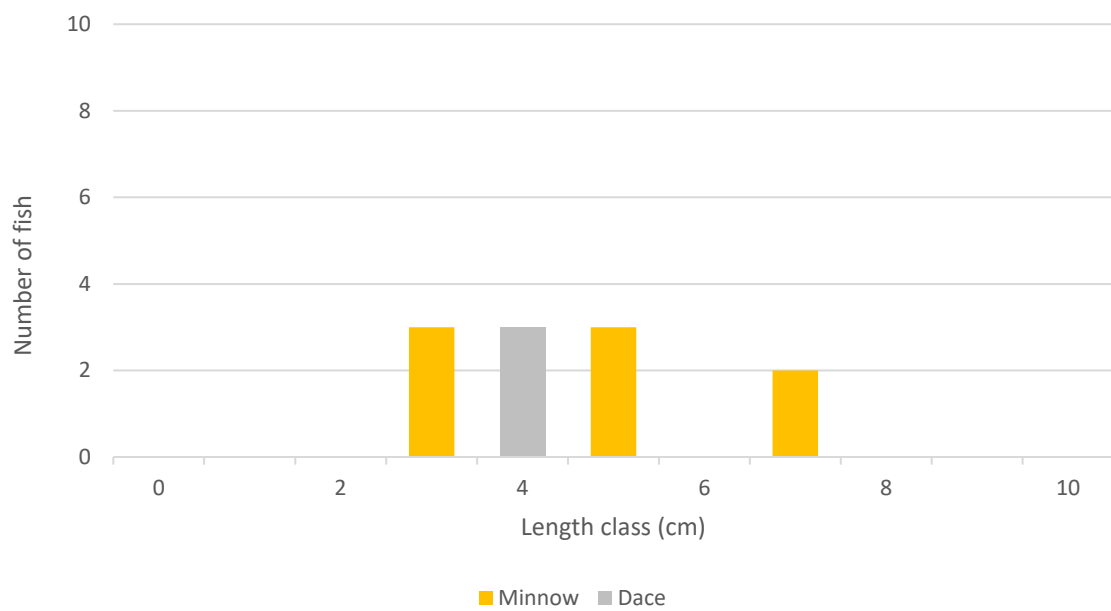
#### 3.1 Fisheries assessment (electro-fishing)

##### 3.1.1 Site A (within proposed works area)

Site A was located on the east bank of the River Barrow in the vicinity of the proposed outfall pipe works area (**Figure 2.2**). The river was a large lowland depositing watercourse (FW2; Fossitt, 2000) that averaged 30-35m wide and ranged from 1.2m deep in the margins to >3m in the central channel. The area was dominated by deep slow-flowing glide with localised area of deeper pool in the centre channel. The littoral area supported imperceptible flows and featured steeply-sloping banks of soft sediment (silt), which were invariably very deep (up to 0.3-0.4m) and near-anoxic in most areas. The littorals adjoined mixed coarse gravels with occasional cobble and boulder at the base of the marginal slope. The east bank of the river supported dense overhanging grey willow (*Salix cinerea*), crack willow (*Salix fragilis*) and osier (*Salix viminalis*). Riparian shading was high and this resulted in only limited macrophyte growth along the margins of the channel. This included occasional submerged arrowhead (*Sagittaria sagittifolia*) in addition to invasive Nuttall's pondweed (*Elodea nuttallii*). Nuttall's pondweed had increased in the littorals of the channel due to reduced flows in July 2025.

Minnow (*Phoxinus phoxinus*) and dace (*Leuciscus leuciscus*) were the only fish species recorded via electro-fishing from site A, situated in the footprint of the proposed outfall area (**Figure 3.1**). Despite the presence of abundant, organic-rich soft sediment areas, no lamprey ammocoetes were recorded from targeted electro-fishing of 3 no. contiguous 1m<sup>2</sup> areas. Dense overhanging growth of willow species had resulted in little to no flows along the river margins and very heavy shading thus creating conditions inimical to larval lamprey (**Plate 3.1**). The site, however, had some value as a coarse fish nursery habitat with both juvenile minnow and dace recorded (**Plate 3.2**).





**Figure 3.1** Length frequency distribution recorded via electro-fishing at site A on the River Barrow, July 2025



**Plate 3.1** Dense willow growth adjoining site A resulting in poor mixing of flow and accretion of anoxic sediment, July 2025



**Plate 3.2** Juvenile dace captured at site A, July 2025

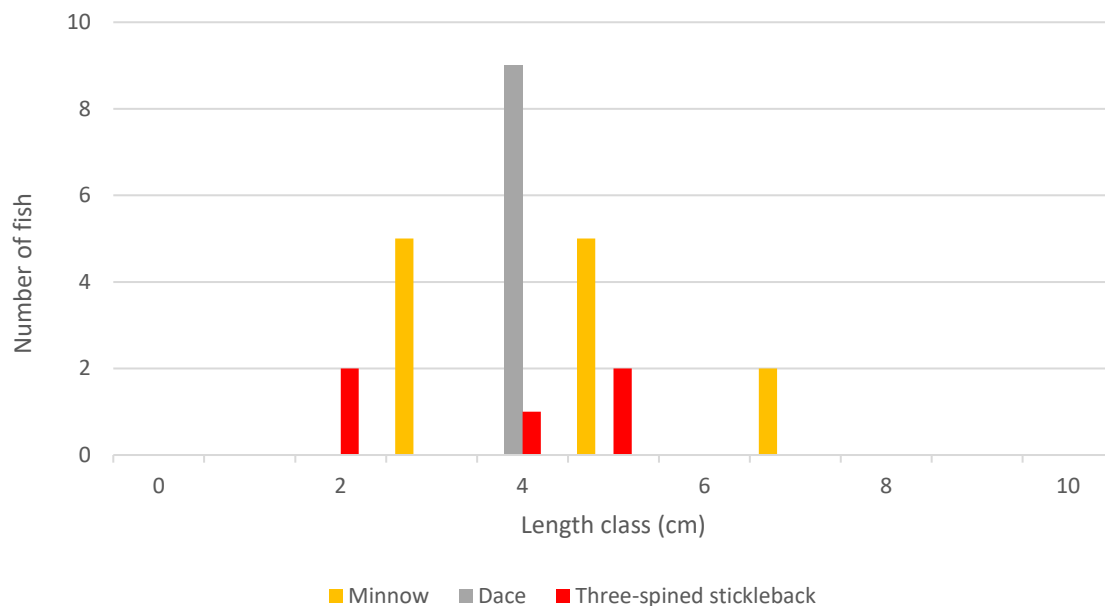
### 3.1.2 Site B (downstream of proposed works area)

Site B was located in a small bay on the east bank of the River Barrow, approximately 30m downstream of the proposed outfall pipe works area (**Figure 2.2**). The site represented one of the few areas accessible to backpack electro-fishing in the vicinity of the proposed outfall works (i.e., <1.3m in depth). As per upstream, the river depths ranged from 1.1-1.3m in the margins to >3m in the central channel. The area was dominated by deep slow-flowing glide with localised area of deeper pool in the centre channel. The marginal substrata were dominated by organic-rich silt and sand (up to 0.2m in depth), grading into mixed gravels and occasional cobble and boulder at the base of the steep marginal slope. The site adjoined a residential property garden (GA2) and was more open than site A (historical tree clearance), with lower cover of overhanging trees. Thus, the area received some influence from currents, given the absence of overhanging trees and limbs which would otherwise restrict flow. However, flows were noticeably reduced when comparing July 2021 with the current July 2025 survey due to the dry spring. Macrophytes included occasional yellow water lily (*Nuphar lutea*), submerged arrowhead, with emergent water mint (*Mentha aquatica*) and reed canary grass (*Phalaris arundinacea*) along channel margins. The cover of invasive Nuttall's pondweed (*Elodea nuttallii*) had increased significantly in open areas of the bank inclusive of in the vicinity of site B. This was considered to provide improved nursery conditions for cyprinid fish and stickleback species.

Minnow, dace and three-spined stickleback (*Gasterosteus aculeatus*) were the only fish recorded during targeted electro-fishing at site B in July 2025 (**Figure 3.2**). During the previous survey in July 2025 low densities of *Lampetra* sp. ammocoetes were recorded, equating to a density of 1 per m<sup>2</sup> of targeted habitat fished. However, none were recorded in the current survey. The increased marginal flows and reduced riparian shading compared with site A provided improved



ammocoete habitat, albeit the quality of nursery conditions was reduced between the current (2025) and previous (2021) survey. The reduced flows and increase in anoxic sediment conditions limited the suitability of ammocoete burial habitat during the current survey. The site was of greater value as a coarse fish nursery habitat with an observed increase in the densities of dace and minnow. These cyprinid fish likely benefited from the increased cover of Nuttall’s pondweed at site B. The comparison of the fish recorded between July 2021 and July 2025 is summarised in **Table 3.1** below.



**Figure 3.2** Length frequency distribution recorded via electro-fishing at site B on the River Barrow, July 2025



**Plate 3.4** Representative image of site B on the River Barrow, July 2025 (located immediately downstream of the proposed outfall works area)



**Plate 3.5** Juvenile cyprinid fish including minnow were frequent at site B, July 2025



**Plate 3.6** *Lampetra* sp. ammocoete recorded from site B (downstream of the proposed outfall works area) during previous July 2021 survey (not recorded in July 2025)



**Table 3.3** Comparison of fish recorded via electro-fishing between July 2021 and July 2025

| Site no. | July 2021                                 | July 2025                                            | Notes                                                                                                                                                                                                                               |
|----------|-------------------------------------------|------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| A        | Minnow (7) & three-spined stickleback (1) | Dace (3) & minnow (8)                                | Dace and minnow recorded in 2025. Previously small numbers of three-spined stickleback and minnow were recorded                                                                                                                     |
| B        | <i>Lampetra</i> sp. (3) & minnow (4)      | Three-spined stickleback (5), dace (9) & minnow (13) | Increase in the numbers of cyprinid fish between 2021 and 2025, likely associated with the reduced flows and increase in cover of Nuttall's pondweed. Lamprey ammocoetes recorded at low densities in 2021 but not recorded in 2025 |



**Plate 3.7** Electro-fishing of marginal silt at site B, July 2025

## 3.2 Bathymetric (SONAR) survey

### 3.2.1 Bathymetry

The SONAR survey conducted during July 2021 (Triturus, 2021) confirmed the high average mean depth of the River Barrow ( $2.4\text{m} \pm 0.54\text{m SD}$ ) in vicinity of the proposed outfall works area (**Figure 3.3**). As illustrated in **Figure 3.3**, the River Barrow followed a typical trapezoidal profile, with shallow margins steeply grading into a deeper centre channel of  $>3\text{m}$ . The minimum depth logged along the proposed works area (east bank) was  $1.5\text{m}$ , although instream wading of marginal areas not accessibly by boat revealed a typical depth of approximately  $1.2\text{m}$  under the overhanging willow canopy on a steeply-sloping river margin. The current 2025 bathymetric data output focused on the repeat of the bottom hardness study to establish potential changes in the distribution of larval lamprey soft sediment burial habitat (section 3.2.2 below).

### 3.2.2 Bottom (substrate) hardness

The plot of bottom (substrate) hardness between 2021 and 2025 (**Figures 3.4 & 3.5**, respectively) shows a mixture of both soft and harder substrata (gravels, cobble, occasional boulder) in the footprint of the proposed works area. Broadly, the distribution of soft sediments bordered the shallower east and west banks of the study area where increased rates of sediment accretion occur. Evidently, the areas of softer sediment (lighter shading) were restricted to the depositing channel margins along the east bank (that are covered by an extensive willow canopy and limbs that encourage deposition). These findings were supported by observing the bed with a bathyscope in strong sunlight. While such habitat can support lamprey ammocoetes (chosen for burial by juveniles), bathyscope and electro-fishing surveys carried out along the margins confirmed the near-anoxic soft sediment in this area was invariably deep (between  $0.4\text{m}$ - $0.5\text{m}$  in depth) with very limited aeration due to restricted flow. A narrow band of soft sediment was also present along the east bank downstream of the proposed works area (i.e., in site B). During the 2021 survey this area supported shallower (maximum of  $0.3\text{m}$ ), lighter coloured, well-mixed sand, silt and organic matter. The silt layer had deepened in 2025 with noticeably darker coloured silt supporting increased anoxic conditions due to prolonged lower flow conditions (pers. obs.). This area was situated outside the main bathymetric study area but the pattern of softer substrata can be seen in the southwestern area of the sounding plot on **Figures 3.4 & 3.5**.



**Figure 3.3** Bathymetry map of the proposed Mortarstown WWTP outfall works area, (darker shading indicates deeper water) Triturus data (2021)





**Figure 3.4** Bottom hardness map of the proposed Mortarstown WWTP outfall works area, July 2021 (lighter shading indicates softer substrata)



**Figure 3.5** Bottom hardness map of the proposed Mortarstown WWTP outfall works area, July 2025 (lighter shading indicates softer substrata)

## 4. Discussion

There was no suitability for lamprey ammocoetes within the proposed Mortarstown WWTP outfall works area (site A) despite the presence of soft substrata that could support lamprey ammocoetes (**Figure 3.4**). The soft sediment overlapping the proposed works area was considered unsuitable for lamprey ammocoetes, given high shading, poorly oxygenated sediment and poor flow rates (refer to section 3.2.2 of results). This was concluded during both the initial July 2021 and repeat July 2025 survey. The heavy growth of willows and overhanging/submerged limbs encouraged high levels of sediment accretion. However, the high quantities of depositional leaf litter and flow restrictions behind the limbs resulted in slow rates of breakdown and dark black anoxic silt that had very low suitability for lamprey (none recorded during either survey).

Some peripheral, sub-optimal ammocoete habitat (site B) existed a short distance downstream of the proposed outfall area. While a very low density (1 per m<sup>2</sup>) of *Lampetra* sp. ammocoetes was recorded via electro-fishing during July 2021, no larval lamprey were recorded during July 2025. It was noted that the river flows were very low due to the dry spring/summer in 2025 and this may have discouraged larval lamprey settlement into this previously utilised area. Nonetheless, the historically recorded low density at site B was significantly lower than densities recorded downstream of Carlow Weir, 1.6km upstream of the study area. At Carlow Weir, >30 lamprey ammocoetes per m<sup>2</sup> were recorded in 2018 (Macklin et al., 2018) supporting the species' requirement for soft, organic rich and non-anoxic sediments. Conclusively, the area of river channel in vicinity of the proposed works were of low value to lamprey in terms of both spawning (i.e. no finer mixed gravels) and poor nursery habitat (sub-optimal). In this respect, lamprey ammocoetes require the deposition of fine, organic-rich sediment ≥5cm in depth in which to burrow and mature (Aronsoo & Virkkala, 2014; Goodwin et al., 2008; Gardiner, 2003). Furthermore, their survival depends on a permanent unidirectional water flow, to supply them with the proper nutrients, while promoting the exchange of respiratory gases and metabolic residues (Ferreira et al., 2013; Hardisty & Potter 1971).

The narrow band of soft sediment areas along the east bank of the River Barrow within the vicinity of proposed works area was broadly consistent between the two survey periods (**Figures 3.4 & 3.5**). However, while the soft sediment distribution was similar, the condition of the sediment for ammocoetes had declined. This was considered as a result of very low flows given high riparian shading from willow trees and limbs, thus encouraging more accretion of anoxic sediments. Evidently, this resulted in conditions inimical to larval lamprey (none recorded via electro-fishing at either location). Site B, located approximately 30m downstream of the proposed works area, was a more open habitat with lighter coloured silt, sand and organics than site A, during the previous July surveys when a low density of ammocoetes was recorded. However, the poorer flows recorded in July 2025 and associated reduced oxygenation of sediments resulted in darker anoxic silt. Consequently, while this area previously supported more favourable conditions for lamprey during July 2021 (i.e., organic-rich, better-oxygenated soft sediment), it appeared to be of significantly lower suitability in July 2025. The lower flow rates and poorer mixing of currents may have also impacted the larval drift settlement of ammocoetes. No finer well oxygenated gravels were present in the vicinity of the study area, indicating an absence of nearby suitable spawning areas adjoining soft sediment burial habitat.



Although it is becoming more widely accepted that larval lamprey may burrow at greater depths than previously thought (up to 1.5m), the optimal nursery water depth for *Lampetra* species (i.e., brook and river lamprey) is <1m and often <0.5m (Maitland, 2003). The SONAR survey confirmed that more optimal depths (i.e. <1m) are largely absent from the vicinity of the proposed outfall (**Figure 3.3**). *Lampetra* sp. ammocoetes in particular are known to prefer soft sediment areas with gradients no greater than 1% (Kelly & King, 2001). The marginal slopes of both the survey area, and much of the main channel of the River Barrow, are typically much steeper than this (Macklin et al., 2018; Triturus, 2017; pers. obs.) and are, thus, largely unsuitable for ammocoete settlement and burial. The exceptions to this are downstream of weirs and canal locks in addition to the confluence points of small tributaries and drains.

In support of previous findings on the River Barrow (Delanty et al., 2017; Triturus, 2017; King, 2006), lamprey spawning and ammocoete habitat was highly localised and limited in extent within the vicinity of the works area. Overall, the main channel of the River Barrow provides typically poor habitat for lamprey (Delanty et al., 2017) given the predominance of deep, slow-flowing glide with steep margins. As stated previously, the nearest good-quality lamprey habitat to the Mortarstown WWTP survey area was identified via electro-fishing surveys in 2018 immediately below Carlow Weir (1.6km upstream), where relatively high densities of *Lampetra* sp. were recorded (i.e., > 30 per m<sup>2</sup>). A low density of *Lampetra* sp. ammocoetes (2.6 per m<sup>2</sup>) was also recorded on the Barrow at Clongrennan lock, approximately 1.6km downstream of the proposed works area, in September 2020 (Triturus, 2020).

Whilst of low value for lamprey, the wider survey Mortarstown WWTP outfall area was of value as a coarse fish habitat. Indeed, the margins of channel, which supported macrophytes inclusive of invasive Nuttall's pondweed, provided good nursery conditions for juvenile cyprinids. Evidently the current survey supported increased numbers of minnow and dace between the July 2021 and July 2025 survey periods (**Table 3.1**). The deep margins and overhanging tree canopies along the east bank of the River Barrow (i.e., proposed works area) also provided good cover and nursery habitat for a range of species. This included species synonymous with the River Barrow including perch (*Perca fluviatilis*), dace (*Leuciscus leuciscus*) and roach (*Rutilus rutilus*). The adjoining deeper central channel (up to >3m) also provided good-quality coarse fish habitat for roach, dace, bream (*Abramis brama*) and bream hybrids, as well as adult pike (*Esox lucius*); these findings were consistent between the July 2021 and July 2025 surveys. This deeper glide was not considered to be of high value for adult salmonids (as holding habitat) or juveniles, given slow flow rates and a more homogenous profile. Better holding habitat exists in the faster flowing deep glide and pool downstream of Carlow Weir for approximately 250m. Good quality salmonid nursery habitat also (i.e., faster-flowing areas of riffle, supporting more varied cobble and boulder substrata) also exists downstream of Carlow Weir. The accelerated flows at Carlow Weir also provide spawning for salmon where mixed cobble, coarse and medium gravels provide spawning opportunities in pool tailings. Further good-quality nursery, spawning and holding habitat is also present downstream, near Clongrennan Lock. Historically, these areas were found to support moderate numbers of Atlantic salmon parr and low numbers of brown trout (Triturus, 2020; Macklin et al., 2018). On the main channel of the River Barrow (excluding tributaries) the best quality salmonid and lamprey habitat is found in the downstream vicinity of weirs, where flow rates are naturally higher (Delanty et al., 2017; King, 2006; pers. obs.).



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# Appendix B. Alluvial Woodland Survey Report (O'Connor, 2023)





# Mortarstown Wastewater Treatment Plant

## Assessment of River Corridor Woodland

**Version:** Rev3 - updated following Uisce Éireann review

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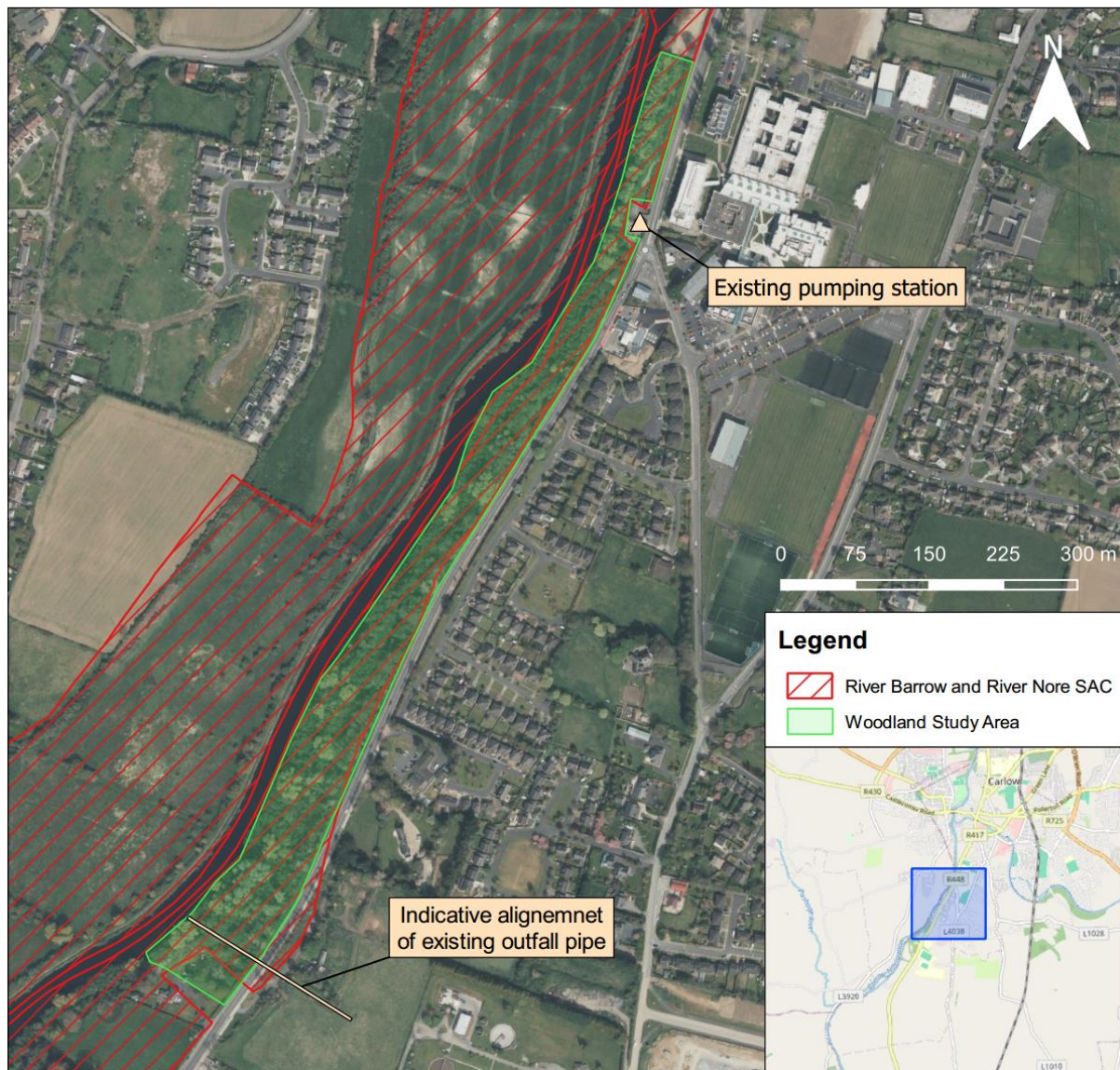
**Date:** 3rd May 2024

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## 1. Introduction

Uisce Éireann is in the process of upgrading the wastewater treatment plant and associated pumping station and outfall in the vicinity of Mortarstown, Carlow Town, Co. Carlow. The existing infrastructure lies adjacent to the River Barrow (see Figure 1), which supports continuous woodland cover along the river corridor. The study area is within the River Barrow and River Nore SAC (see Figure 1), for which the Annex I priority habitat ‘\*Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion*, *Alnion incanae*, *Salicion albae*)’ (code: 91E0) is a qualifying interest.



**Figure 1: Study area for assessment of river corridor woodland at Mortarstown, showing overlap with the River Barrow and River Nore SAC.**

AtkinsRéalis was contracted to provide environmental services in relation to the proposed project, including preparation of a Natura Impact Statement assessing the implications for the integrity of the SAC. To that end, a consultant botanical ecologist, Mary O'Connor PhD, was engaged to assess the occurrence and extent of alluvial woodland habitat in the general area of the proposed project. This habitat assessment is to support the Natura Impact Statement.

### 1.1. Note on Rev 2.0 and Subsequent Revisions

Following on from a project team meeting in December 2023, it was decided that classifying the vegetation composition of the alluvial woodland habitats in the study area using the Irish Vegetation Classification (IVC) would add further value to the survey data by facilitating comparison with sites of similar vegetation composition. The IVC seeks to provide a single, unified framework which describes in detail all Irish natural and semi-natural vegetation based on floristic composition alone. As such, it is not a habitat classification, but is useful in identifying habitats when used in conjunction with other information (e.g. on edaphic conditions, topography, hydrological regime and management practices) in the context of an appropriate habitat classification system. Mixed broadleaf woodland, scrub and other non-Annex I habitats were not included in the IVC classification of the site.

## 2. River Barrow and River Nore SAC

The Barrow River in the study area in Co. Carlow forms part of the River Barrow and River Nore SAC (Site Code: 002162). A summary of the Site Synopsis for this SAC is provided below.

*‘This SAC consists of the freshwater stretches of the Barrow/Nore River catchments as far upstream as the Slieve Bloom Mountains and it also includes the tidal elements and estuary as far downstream as Creadun Head in Waterford. The larger of the many tributaries include the Lerr, Fushoge, Mountain, Aughavaud, Owenass, Boherbaun and Stradbally Rivers of the Barrow and the Delour, Dinin, Erkina, Owveg, Munster, Arrigle and King’s Rivers on the Nore. Both rivers rise in the Old Red Sandstone of the Slieve Bloom Mountains before passing through a band of Carboniferous shales and sandstones.*

*The upper reaches of the Barrow also run through limestone. The middle reaches and many of the eastern tributaries, sourced in the Blackstairs Mountains, run through Leinster Granite. The southern end runs over intrusive rocks poor in silica.’*

The site is an SAC selected for alluvial wet woodlands and petrifying springs, priority habitats on Annex I of the E.U. Habitats Directive. The site is also selected as an SAC for old oak woodlands, floating river vegetation, estuary, tidal mudflats, *Salicornia* mudflats, Atlantic salt meadows, Mediterranean salt meadows, dry heath and eutrophic tall herbs, all habitats listed on Annex I of the E.U. Habitats Directive. The site is also selected for the following species listed on Annex II of the same directive – Sea Lamprey, River Lamprey, Brook Lamprey, Freshwater Pearl Mussel, Nore Freshwater Pearl Mussel, Crayfish, Twaite Shad, Atlantic Salmon, Otter, Desmoulin’s Whorl Snail *Vertigo moulinsiana* and the Killarney Fern. Other habitats which occur throughout the site include wet grassland, marsh, reed swamp, improved grassland, arable land, quarries, coniferous plantations, deciduous woodland, scrub and ponds.

Site-specific conservation objectives for the River Barrow and River Nore SAC were published in July 2011. The conservation objective for each qualifying interest, for which the SAC was selected, is to maintain or restore, as appropriate depending on the current conservation status of the qualifying interest, the favourable conservation condition of the Annex I habitat or Annex II species, as defined by a specific list of attributes and targets.

This report looks in more detail at the alluvial wet woodland habitat, Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion*, *Alnion incanae*, *Salicion albae*)’ (code: 91E0) which occur in an area of proposed wastewater infrastructure works, south of Carlow town centre.

### 2.1. Alluvial Woodland in the Barrow Nore SAC

‘\*Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion*, *Alnion incanae*, *Salicion albae*)’ (code: 91E0), or “alluvial woodland” for short, is a natural habitat type listed on Annex I to the Habitats Directive (92/43/EEC) and covers a number of different woodland types, including the following as described for the River Barrow and River Nore SAC (NPWS 2011):

- Gallery woodland dominated by tree willows, principally *Salix triandra*, *S. alba*, *S. fragilis* and *S. viminalis*. This community consists of small, narrow stands on the riverbanks and islands where the trees are subject to frequent flooding and/or have their roots permanently in water. It occurs principally in the lower reaches of the rivers where there is tidal influence. The vegetation is typically characterised by a tangle of fallen and sprawling trees and shrubs and a luxuriant tall herb layer, which includes nettle, reed canary-grass and bindweed.

- Ash-ivy woodland with wood avens and wood speedwell. This community occurs further back from the river where flooding is less frequent, and the soils normally dry out in the summer. Typically, it is species-rich with a rich shrub and field layer, often including abundant geophytes, e.g. celandine, bluebell, wild garlic.
- Alder-meadowsweet woodland. Communities of wet, gleyed soils which are either frequently inundated or have a permanently high-water table. Three sub-types are recognised, depending on the hydrology. Typically, they occur in depressions within the ash woodlands or are associated with seepage zones or springs.

Many of the alluvial woodlands, especially the gallery woodlands, are relatively narrow stands.

Non-annexed ash woodlands and conifer plantations often provided continuity of woodland cover.

Alluvial woodland is a qualifying interest of the River Barrow and River Nore SAC, with its conservation objective being to restore its favourable conservation condition in the SAC.

A target specified in the River Barrow and River Nore SAC *Conservation objectives supporting document – woodland habitats* (NPWS 2011) should be to increase native woodland size to 3ha for small woods and 25ha for large woods, based on the recommendations of Peterken (1993). However, the topography, land ownership and surrounding land use may constrain these targets.



### 3. Understanding the Alluvial Woodland Habitat

In *Irish Wildlife Manual No. 146: Monitoring and assessment of four Annex I woodland habitats*, Daly et al. (2023) describe alluvial woodland as being widespread but localised in Ireland, sometimes occurring as part of a mosaic with other woodland types. Hydrology is the main factor determining the vegetation, with Daly et al. (2023) stating that “*Flooding may occur frequently (annually or more often) or infrequently (at intervals of several years)*”. The IVC shows affinities between all communities in the WL3 ‘*Alnus glutinosa – Filipendula ulmaria* group’ with the Annex I priority habitat ‘\*Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion*, *Alnion incanae*, *Salicion albae*)’ (91E0) and Daly et al. (2023) states that “*Where a vegetation type is assigned to the WL3 group and conforms to the criteria above regarding hydrological conditions, it should be classified as 91E0*”.

The alluvial woodland in the study area is also considered to broadly correspond to the British National Vegetation Classification type W6 *Alnus glutinosa-Urtica dioica* (as defined in Rodwell 1991). These are also known as sequential successional, or mosaic forests and typically comprise fast-growing, early successional woody species in the overstorey (e.g. willow, alder, and or birch as is found in many areas of the River Barrow corridor, including the woodland corridor south of Carlow Town) and as such, rely on periodic disturbances for the replacement of suitable regeneration sites for these species. The pioneer woodland species making up residual alluvial forests often do not survive more than 60-80 years (Rood & Mahoney, 1990; Décamps, 1996) and thus, medium to high-magnitude floods are needed at least every circa 50 years for forest renewal (Cordes et al., 1997). According to Brinson's conceptual model (1990), where the frequency and magnitude of floods are inversely proportional, low-frequency high magnitude floods affect the whole floodplain and significantly alter the landscape (e.g. create oxbow lakes). Extensive regeneration of riparian communities can be associated with these flooding events (Cordes et al., 1997). Medium-power intermediate-frequency floods are also important for the creation of suitable sites for regeneration. For example, 1-in-20-year floods are necessary to maintain riparian regeneration; these medium-sized floods act to clear away vegetation and contribute fine sediments to create regeneration niches (Cordes et al., 1997). Low magnitude, high frequency floods do not play a significant role in terms of the creation of regeneration sites but are important for the replenishment of underground water sources, sediment deposits and for the maintenance of the establishment sites of pioneer communities (e.g. removal of aggressive competitors) (Stromberg & Patten, 1990). Where the timing, intensity, frequency and (or) duration of flood disturbances are disrupted and become insufficient to maintain typical early successional woody riparian species assemblages, there will either be a gradual transformation of the floodplain woodland towards a climax hardwood community, regenerated through autogenic processes (e.g. competition and gap formation) (Amoros et al., 1987a).

The woodland vegetation communities within a river basin are naturally diverse reflecting the patterns in valley morphology and the dynamics of fluvial metamorphosis (Piegay et al., 2000). A typical floodplain should exhibit patch-scale variation ordered along a gradient from species-poor pioneer communities on frequently disturbed ground to more diverse riparian woodland with species such as alder and willow on older stable deposits which, in time, is invaded by species such as ash or oak. In poorly drained areas the disturbance-dependant alder communities will persist. However, on better drained alluvial soils where flooding has become infrequent due to stabilisation of the river channel, terrestrial succession will lead to mixed broadleaved woodland, including oak, ash and sycamore. In addition to this natural diversity, anthropogenic pressures have altered the course of natural succession and vegetation development can be interrupted.

It is therefore important to consider the mosaic and continuum nature of the riparian/alluvial woodland habitat which generally displays a vegetation which follows a gradient from areas of standing water through areas of frequent to infrequent flooding and dry areas where naturally oak/ash woodlands become dominant. The woodland cannot be considered to follow a single hydrological regime but to contain sites of many hydrological and ecological niches. It is therefore not possible to draw boundary lines on vegetation which is by its nature a mosaic type, including wet, damp and dry facies as part of a complex mosaic which should be considered together as an ecological unit.

The *Interpretation Manual of EU Habitats* (DG Env, 2013) definition of the priority Annex I habitat ‘\*Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion*, *Alnion incanae*, *Salicion albae*)’ (91E0) is presented in Appendix 4. This definition focusses on vegetation composition and the interaction of hydrological regime and edaphic factors.

## 4. Site Investigation

### 4.1. Field Survey

A site visit was carried out in June 2023 as part of site assessment.

This survey involved a walk-over of the site. An inventory of the occurrence of habitat and species of conservation importance at the site was carried out in the field. Habitats were classified using the standard nomenclature from *A Guide to Habitats in Ireland* (Fossitt 2000) and the constituent species were recorded in these habitats; a full species list is presented in Appendix 1. The floristic composition of riparian woodland areas was also classified using the IVC.

In tandem with this habitat assessment a topographical survey of the site was also carried out which showed in detail elevation levels at the site; see Appendix 2.

### 4.2. Habitats, following the Fossitt (2000) Classification, and Woodland Communities, following the IVC

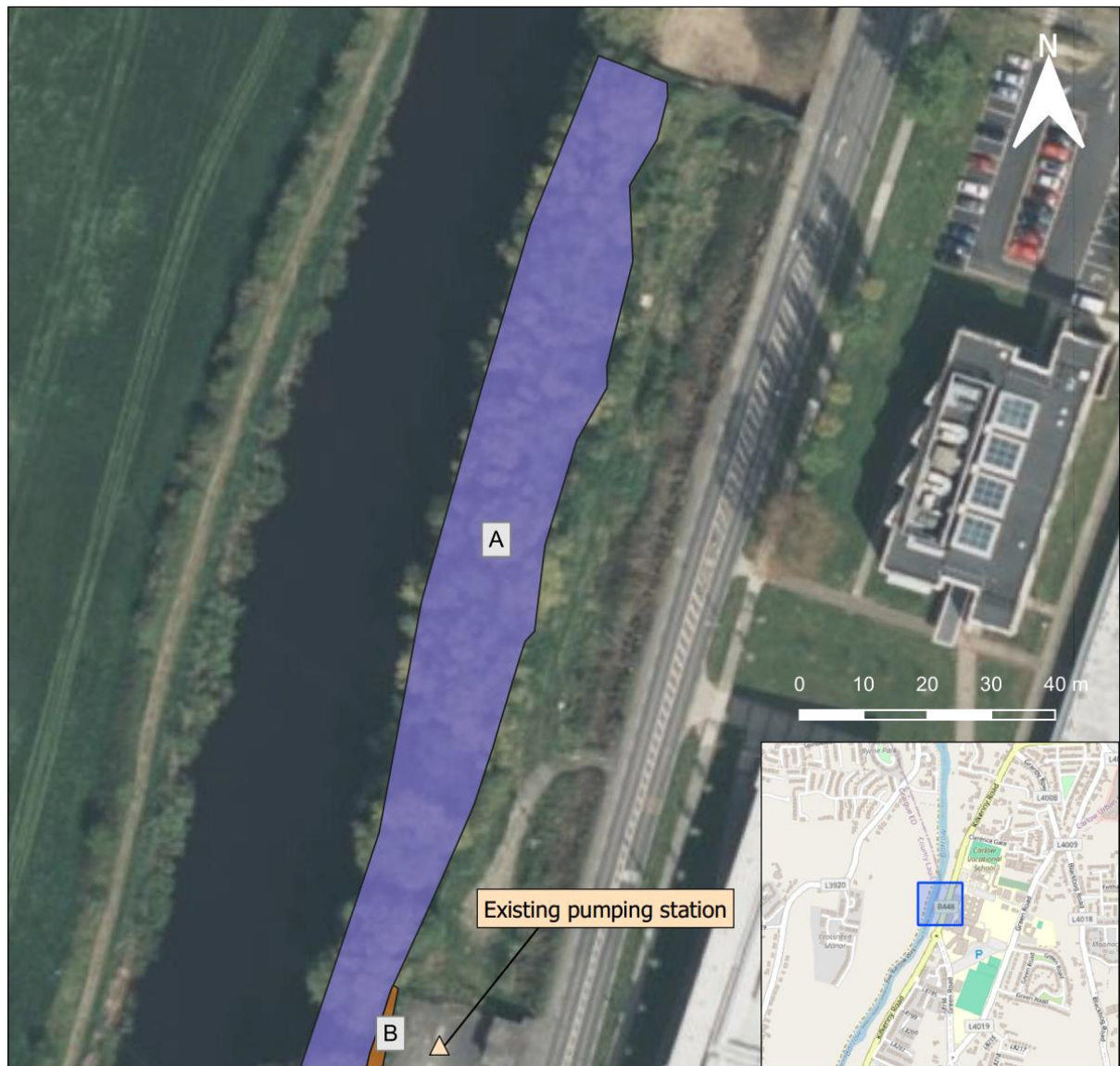
#### 4.2.1. North and West of the Existing Pumping Station

*Dry Meadows and Grassy Verges (GS2), Scrub (WS1) and Riparian Woodland (WN5)*

‘Dry meadows and grassy verges’ (GS2) occurs in an area where there is occasional vehicle access, north of the existing pumping station where the grasses had not recently been cut and had grown tall and become rank. Typical species included Cock’s Foot (*Dactylis glomerata*), Yorkshire Fog (*Holcus lanatus*), False Oat Grass (*Arrhenatherum elatius*), Creeping Buttercup (*Ranunculus repens*), Meadow Vetchling (*Lathyrus pratensis*), Bush Vetch (*Vicia sepium*), Ribwort Plantain (*Plantago lanceolata*), Hogweed (*Heracleum spondylium*), Knapweed (*Centaurea nigra*) and Nettle (*Urtica dioica*). The habitat forms a mosaic with ‘Scrub’ (WS1) dominated by Bramble (*Rubus fruticosus* agg.). There are areas of prolific Hedge Bindweed (*Calystegia sepium*) growing through the bramble layer.

Adjoining this habitat and down the slope, there is a thin strip of mature ‘Riparian woodland’ (WN5) on the banks of the River Barrow, dominated by Willow (*Salix* spp., including *Salix alba*), Alder (*Alnus glutinosa*) and Poplar (*Populus* spp.) trees, with some Hawthorn (*Crataegus monogyna*). Herb species in this habitat include Creeping Bent (*Agrostis stolonifera*), Water Mint (*Mentha aquatica*), Reed Canary-grass (*Phalaris arundinacea*), Wood Dock (*Rumex sanguineus*) and Nettle (*Urtica dioica*). This vegetation composition corresponds to the IVC community ‘*Salix cinerea* – *Urtica dioica* / Grey Willow – Common Nettle woodland’ (code: WL3D). The full IVC synopsis for this community type is presented in Appendix 3. As per this synopsis, stands of this woodland type occurring along rivers and subject to periodic inundation, as is the case here, qualify as priority Annex I alluvial woodland. Similarly, the *Interpretation Manual of EU Habitats* (DG Env, 2013) states that the priority Annex I habitat occurs “on heavy soils (generally rich in alluvial deposits) periodically inundated by the annual rise of the river (or brook) level, but otherwise well-drained and aerated during low-water”, which is also the case here. Therefore, given the vegetation composition, hydrological regime and edaphic conditions, the narrow strip of riparian woodland north and west of the existing pumping station qualifies as priority Annex I alluvial woodland. This area is indicated as zone A in Figure 2 below.

There is some occurrence of the invasive species Himalayan Balsam (*Impatiens glandulifera*) along the riverbank and Water fern (*Azolla filiculoides*) in the shallow water occurring in the shallows water.



**Figure 2: Extent of woodland habitats north of the existing pumping station.**





***Photos 1 and 2: Dry meadow (GS2), scrub (WS1) and a thin strip of riparian woodland (WN5) north of the existing pumping station.***





***Photo 3: 'Salix cinerea – Urtica dioica / Grey Willow – Common Nettle woodland community' (WL3D) north of the existing pumping station.***





***Photo 4: 'Salix cinerea – Urtica dioica / Grey Willow – Common Nettle woodland community' (WL3D) west of the existing pumping station.***



#### 4.2.2. South of the Existing Pumping Station

##### *Scrub (WS1)*

Immediately south of the pumping station is an area of early successional-stage scrub dominated by bramble (*Rubus fruticosus* agg.) with abundant weedy species including nettle (*Urtica dioica*), hedge bindweed (*Calystegia sepium*), false oat-grass (*Arrhenatherum elatius*), great willowherb (*Epilobium hirsutum*), with some immature willow (*Salix* spp.) spreading and sycamore (*Acer pseudoplatanus*). There is no canopy development and very low woody component. This vegetation composition and structure is indicative of past disturbance to the site.



**Photos 5 and 6: 'Scrub' (WS1) immediately south of the existing pumping station.**

This area is indicated as zone D in Figure 3 below. The ground level in zone D is almost entirely above the 1-in-100-year flood level, and the small portion below this level is still above the 1-in-10-year level. As zone D has no canopy, it is not a woodland, and as it is not regularly flooded (nor is there any groundwater flushing), the hydrological regime is not suitable for alluvial woodland. Furthermore, zone D does not provide any significant supporting function to adjacent woodland.





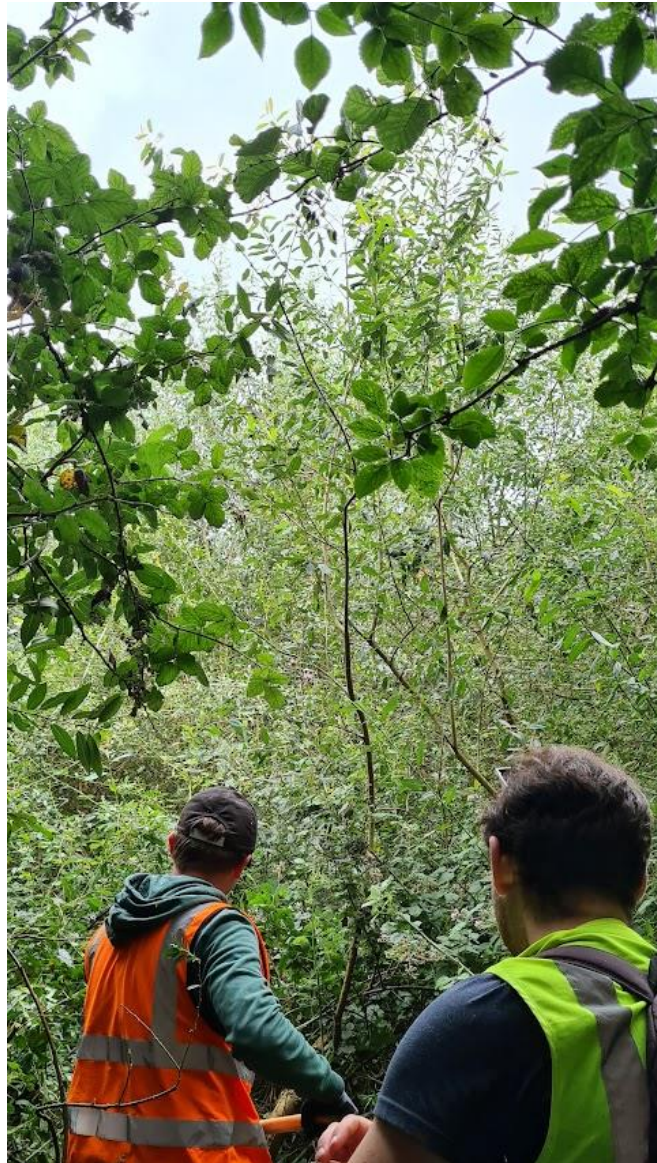
**Figure 3: Distribution and extents of woodland habitats south of the existing pumping station.**

*Mixed Broadleaved Woodland (WD1) with elements of Willow-Alder-Ash Woodland (WN6)*

The woodland habitats in zones A, B and C support canopy species including willows (*Salix* spp.), Alder (*Alnus glutinosa*) and Ash (*Fraxinus excelsior*), mixed with other species such as Sycamore (*Acer pseudoplatanus*), Hawthorn (*Crataegus monogyna*), Birch (*Betula pubescens*) and Elder (*Sambucus nigra*). Meadowsweet (*Filipendula ulmaria*), Remote Sedge (*Carex remota*) and Creeping Bent (*Agrostis stolonifera*) occur in damper areas. Other common components of the field layer include Bramble (*Rubus fruticosus* agg.), Ivy (*Hedera helix*), Creeping Buttercup (*Ranunculus repens*), Meadowsweet (*Filipendula ulmaria*), Nettle (*Urtica dioica*), and Lady-fern (*Athyrium filix-femina*).

Lower in the woodland (indicated as zone A in Figure 3 above), there are open areas of bare exposed soil evidently associated with more frequent inundation from river water and areas of slightly higher elevation where wetland herbaceous species occur such as Meadowsweet (*Filipendula ulmaria*), Creeping Bent (*Agrostis stolonifera*), Water Mint (*Mentha aquatica*), Wood Dock (*Rumex sanguineus*) and species indicative of disturbance such as Nettle (*Urtica dioica*) and enrichment such as Creeping buttercup (*Ranunculus repens*). These species are common elements of alluvial woodland habitat. As

per the woodland north of the pumping station, the floristic composition of zone A is reflective of IVC community type WL3D and the habitat qualifies as priority Annex I alluvial woodland.



***Photo 7: 'Salix cinerea – Urtica dioica / Grey Willow – Common Nettle woodland community' (WL3D) south of the existing pumping Station.***

In the area indicated as zone B in Figure 3 above, there is a narrow band of woodland which reflects a transitional woodland community, with some characteristics of priority Annex I alluvial woodland in terms of canopy composition, but the soil is lower in alluvium and less frequently inundated. Above the 1-in-10-year flood level, the combination of floristic composition, hydrological regime and edaphic conditions were observed to no longer meet the criteria for priority Annex I alluvial woodland, while still being broadly reflective of the IVC community type WL3D and providing continuity of canopy cover and source of regenerative capacity for the adjoining priority Annex I alluvial woodland in zone A following flooding or other disturbance.

As the change in habitat type from zone A to zone B is gradual, the boundary between the zones as mapped in Figure 3 above indicates the upper edge of this continuum, thus the area mapped as zone A indicated the maximum extent of the priority Annex I habitat.



Further up the slope from the river, above the 1-in-100-year flood level, in the area indicated as zone C in Figure 3 above, species such as Ivy (*Hedera helix*), Herb-Robert (*Geranium robertianum*), Lesser Celandine (*Ficaria verna* subsp. *verna*) become more common as the woodland floor becomes drier and more stable. The vegetation in zone C represents 'Mixed broadleaved woodland' (WD1) with elements of 'Wet willow-alder-ash woodland' (WN6). Canopy species also reflect drier conditions (flooded only very infrequently), with species such as Horse Chestnut (*Aesculus hippocastanum*) occurring here. This strip of woodland does not correspond to any Annex I habitat and unlikely provides any supporting function (for the priority Annex I alluvial woodland in zone A) other than continuity of high-canopy cover and as a buffer from non-woodland habitats.

The invasive alien species Himalayan Balsam (*Impatiens glandulifera*), Winter Heliotrope (*Petasites pyrenaicus*) and Traveller's Joy (*Clematis vitalba*) also occur in zones A, B, C and D south of the existing pumping station site. During a site visit on 10<sup>th</sup> April 2024, it was evident that most of the part of zones C and D in this area had recently been disturbed, likely during the installation of a new surface water outfall in this area.



**Photos 8 and 9: Transitional area of high-canopy woodland south of the existing pumping station - 'Mixed broadleaved woodland' (WD1) with elements of 'Wet willow-alder-ash woodland' (WN6), note bare ground in lower areas of woodland with more frequent inundation and ivy cover on the woodland floor upslope from river.**





***Photos 10 and 11: Transitional area of high-canopy woodland south of the existing pumping station - 'Mixed broadleaved woodland' (WD1) with elements of 'Wet willow-alder-ash woodland' (WN6), note bare ground in lower areas of woodland with more frequent inundation and ivy cover on the woodland floor upslope from river.***

#### 4.2.3. Woodland Associated with the Outfall Pipe

##### *Scrub (WS1) and high-canopy Riparian Woodland (WN5)*

At the time of survey, along the line of the outfall was an area of low-canopy<sup>1</sup> willow and bramble scrub with abundant weedy species nettle, hedge bindweed, false oat-grass, great willowherb, with some grey willow spreading, sycamore, elder and hazel. This area is mapped as zone E in Figure 4 below. The ground level here was artificially raised in the past and is well above the 1-in-100-year flood level, with little to no alluvium content in the soil. Zone E does not qualify as priority Annex I alluvial woodland habitat and does not provide suitable hydrological regime or soil conditions for this habitat. This scrub provides limited supporting function for the adjoining priority Annex I alluvial woodland in zone A, i.e. continuity of woodland canopy and a source of willow regeneration following damage. This

<sup>1</sup> The canopy in zone E is low (<5m above ground level) but is at a similar level to the adjoining high-canopy alluvial woodland in zone A as the ground level is raised significantly.



vegetation composition and structure in zone E is indicative of past disturbance. Furthermore, during a site visit on 10<sup>th</sup> April 2024, it was evident that most of the willow and bramble scrub along the outfall line had recently been clear and the ground levelled, leaving only one small stand of low-growing willows immediately adjacent to the outfall alignment through zone E (see Photo 12 below).



**Photo 12: Recent clearance and ground levelling over outfall alignment (indicative alignment shown in red).**

The artificially raised ground in zone E falls sharply into an area dominated by White Willow (*Salix alba*) on the banks of the River Barrow; indicated as zone A in Figure 4 below. This vegetation composition of woodland here corresponds to the IVC community type WL3D. This woodland is contiguous with the priority Annex I alluvial woodland to the north, dominated by White Willow (*Salix alba*). Other species occurring here which are positive indicator species for alluvial woodland habitat include Alder (*Alnus glutinosa*), Hawthorn (*Crataegus monogyna*), Ash (*Fraxinus excelsior*), Grey Willow (*Salix cinerea*) and other willows (*Salix* spp.), and herbaceous species Creeping Bent (*Agrostis stolonifera*), Wild Angelica (*Angelica sylvestris*), Meadowsweet (*Filipendula ulmaria*), Marsh Bedstraw (*Galium palustre*), Flag Iris (*Iris pseudacorus*), Water Mint (*Mentha aquatica*), Reed Canary-grass (*Phalaris arundinacea*), Wood Dock (*Rumex sanguineus*) and Nettle (*Urtica dioica*).

There is a very small remnant population of the invasive alien species Japanese Knotweed (*Fallopia japonica*) in zone E and this part of zone A. This infestation has undergone treatment and is now under effective control, but ongoing monitoring is required.



**Figure 4: Distribution and extents of woodland habitats in the vicinity of the existing outfall pipe.**





***Photos 13 and 14: Willow and bramble scrub (WS1) (left) and riparian woodland (WN5) (right).***

## 5. Linking to the Topographic Survey

A topographic map of the survey area was prepared; see Appendix 2. This, in conjunction with flood heights provided by the OPW, allowed for the identification of areas where 1-in-10-year flood and 1-in-100-year flooding occurred on the site; indicated by the contours in Figures 5 and 6 below.

Figures 5 and 6 show that much of the study area is regularly inundated from the River Barrow and this is reflected in the vegetation composition and soil conditions which were observed on site. Parts of the study area which are above the level of regular inundation, but which still contain a continuum of woodland habitat and some alluvial substratum, were observed to be generally between the 1-in-10-year and 1-in-100-year flood contours, and this is reflected in the mapping of zone B in Figures 3 and 4 above.

As such, the topographical survey results provided a useful basis for accurate mapping of the ecological zonation observed within the woodland study area during the botanical survey.



**Figure 5: Calculated flooding contours for the northern part of the study area.**





**Figure 6: Calculated flooding contours for the southern part of the study area.**

## 6. Conclusion

In conclusion, it is clear that the high-canopy woodland which occurs along the River Barrow within the study area (mapped as zone A) falls under the definition of priority Annex I alluvial woodland (91E0\*), which is listed as a qualifying interest for the River Barrow and Nore SAC. While containing some non-native species in the canopy, the general vegetation composition, hydrological regime and soil conditions conform to the description of 91E0\* in the Interpretation Manual of EU Habitats.

The area of transitional woodland (mapped as zone B) provides a high-canopy buffer and source of regenerative capacity to the to the priority Annex I alluvial woodland and it is therefore important to conserve these areas where possible to provide ecological resilience to the qualifying interest habitat.

The different woodland types in the study area have been defined as follows:

- Zone A, between the river and the 1-in-10-year flood contour (precautionary), represents the priority Annex I alluvial woodland habitat.
- Zone B, between the 1-in-10-year and 1-in-100-year flood contours, represents a transitional area with some elements of alluvial woodland, not corresponding to the priority Annex I habitat but providing an important supporting function.
- Zone C, above the 1-in-100-year flood contour (i.e. only inundated in extreme events), represents a mixed broadleaved woodland with very few elements of alluvial woodland, not corresponding to the priority Annex I habitat and providing only a limited supporting function.
- Zone D, immediately south of the existing pumping station, represents immature scrub, not corresponding to the priority Annex I habitat and not providing any supporting function.
- Zone E, which is on made ground and almost never inundated, represents willow scrub, not corresponding to the priority Annex I habitat and providing only a limited supporting function, and much of this zone has recently been cleared.



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## Appendix 1 - Botanical species list

### *Trees, shrubs and other woody species*

*Acer pseudoplatanus* Sycamore  
*Aesculus hippocastanum* Horse Chestnut  
*Alnus glutinosa* Alder  
*Betula pubescens* Downy Birch  
*Corylus avellana* Hazel  
*Crataegus monogyna* Hawthorn  
*Euonymus europaeus* Spindle  
*Fraxinus excelsior* Ash  
*Hedera helix* Ivy  
*Ilex aquifolium* Holly  
*Malus sylvestris* Crab Apple  
*Pinus sylvestris* Scots Pine  
*Populus alba* White Poplar  
*Quercus robur* Pedunculate  
*Rubus fruticosus* agg. Bramble  
*Salix alba* White Willow  
*Salix cinerea* Grey Willow  
*Salix fragilis* Crack Willow  
*Salix purpurea* Purple Osier  
*Salix viminalis* Osier  
*Sambucus nigra* Elder  
*Ulmus glabra* Wych Elm

### *Herbaceous species*

*Achillea millefolium* Yarrow  
*Agrostis stolonifera* Creeping Bent  
*Alisma plantago-aquatica* Water Plantain (river fringe)  
*Alopecurus pratensis* Meadow Foxtail  
*Angelica sylvestris* Angelica  
*Anthoxanthum odoratum* Sweet Vernal Grass  
*Anthriscus sylvestris* Cow Parsley  
*Apium nodiflorum* Fool's Watercress (river fringe)  
*Arctium minus* Burdock  
*Arrhenatherum elatius* False Oat Grass  
*Asplenium ceterach* Rustyback Fern (on stone wall)

*Asplenium ruta-muraria* Wall Rue (on stone wall)  
*Asplenium scolopendrium* Hart's-tongue  
*Asplenium trichomanes* Maidenhair spleenwort  
*Bellis perennis* Daisy  
*Brachypodium sylvaticum* False Brome  
*Callitriche* sp. Water Starwort (river fringe)  
*Calystegia sepium* Hedge Bindweed  
*Capsella bursa-pastoris* Shepherds Purse  
*Cardamine pratensis* Cuckoo Flower  
*Carex nigra* Common Sedge  
*Carex remota* Remote Sedge  
*Carex sylvatica* Wood Sedge  
*Centaurea nigra* Black Knapweed  
*Centranthus ruber* Red Valerian (on wall)  
*Cirsium arvense* Creeping Thistle  
*Cirsium vulgare* Spear Thistle  
*Cynosurus cristatus* Crested Dogs Tail Grass  
*Dactylis glomerata* Cock's-foot Grass  
*Daucus carota* Wild Carrot  
*Dryopteris filix-mas* Male Buckler Fern  
*Elytrigia repens* Couch-grass  
*Epilobium hirsutum* Great Willowherb  
*Epilobium montanum* Broad-leaved Willowherb  
*Epilobium parviflorum* Hoary Willowherb  
*Equisetum* spp. Horsetail  
*Eupatorium cannabinum* Hemp Agrimony  
*Festuca rubra* Red Fescue  
*Ficaria verna ssp verna* Lesser Celandine  
*Filipendula ulmaria* Meadowsweet  
*Galium aparine* Cleavers  
*Galium palustre* Marsh Bedstraw  
*Geranium robertianum* Herb-Robert  
*Glechoma hederacea* Ground Ivy  
*Glyceria fluitans* Floating Sweet-grass (river fringe)  
*Glyceria maxima* Reed Sweet-grass  
*Holcus lanatus* Yorkshire Fog  
*Heracleum sphondylium* Common Hogweed  
*Iris pseudacorus* Flag Iris

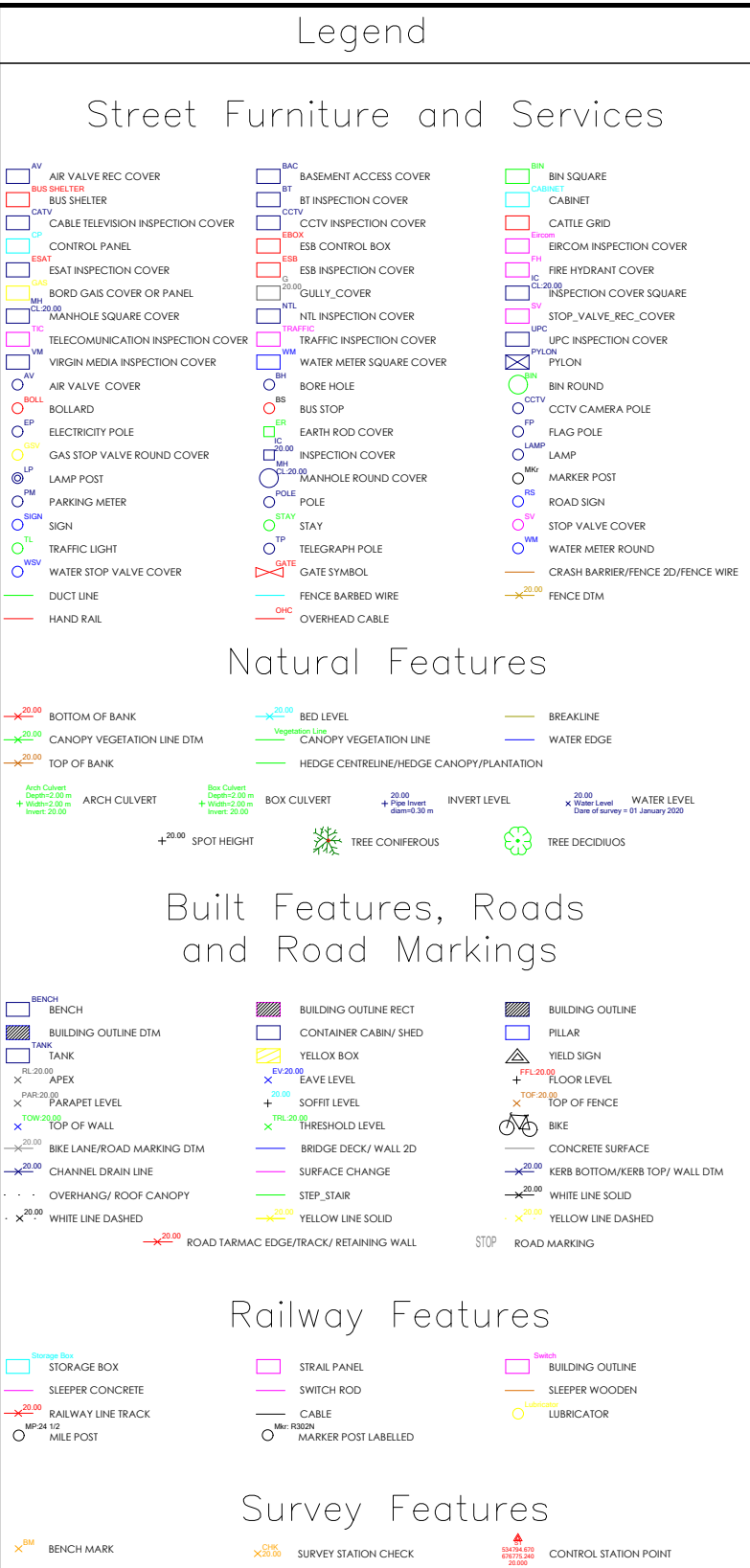


*Mentha aquatica* Water Mint  
*Phalaris arundinacea* Reed Canary-grass  
*Polystichum setiferum* Soft Shield Fern  
*Rumex crispus* Curly Dock  
*Rumex obtusifolius* Broadleaved Dock  
*Rumex sanguineus* Wood Dock  
*Senecio jacobaea* Common Ragwort  
*Urtica dioica* Nettle  
*Vicia* spp. Vetches

*Invasive alien species*

*Azolla filiculoides* Water Fern  
*Clematis vit alba* Traveller's Joy  
*Fallopia japonica* Japanese Knotweed  
*Impatiens glandulifera* Himalayan Balsam  
*Petasites pyrenaicus* Winter Heliotrope

## Appendix 2 - Topographical survey results



|             |                |     |          |
|-------------|----------------|-----|----------|
| C           |                |     |          |
| B           |                |     |          |
| A           | ORIGINAL DRAFT | RR  | 20/07/23 |
| REV:        | DESCRIPTION:   | BY: | DATE:    |
| REV/STATUS: |                |     |          |



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CLIENT **ATKINS**

PROJECT TOPOGRAPHICAL SURVEY

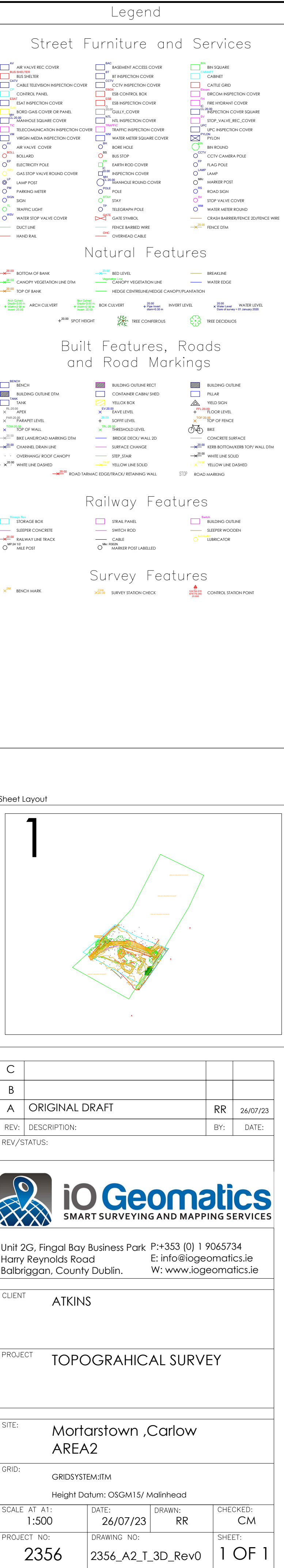
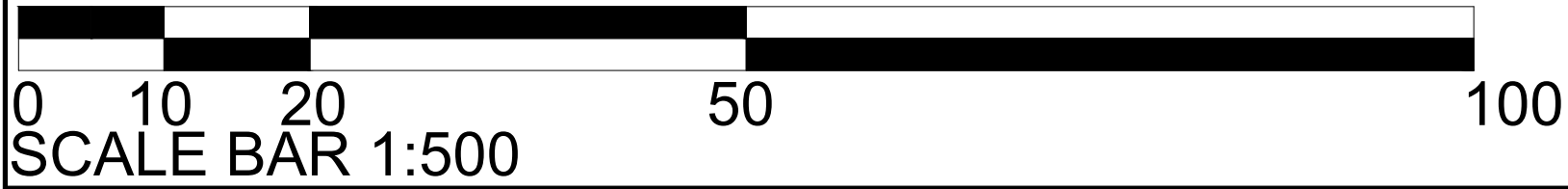
SITE: Mortarstown ,Carlow  
AREA1

GRID: GRIDSYS:ITM

Height Datum: OSGM15/ Malinhead

|                       |                                  |              |                  |
|-----------------------|----------------------------------|--------------|------------------|
| SCALE AT A1:<br>1:500 | DATE:<br>20/07/23                | DRAWN:<br>RR | CHECKED:<br>CM   |
| PROJECT NO:<br>2356   | DRAWING NO:<br>2356_A1_T_3D_Rev0 |              | SHEET:<br>1 OF 1 |







## Appendix 3 - Irish Vegetation Classification community synopsis for WL3D

|                        |                                                      |
|------------------------|------------------------------------------------------|
| <b>Scientific name</b> | <i>Salix cinerea</i> – <i>Urtica dioica</i> woodland |
| <b>Common name</b>     | Grey Willow – Common Nettle woodland                 |
| <b>Community code</b>  | WL3D                                                 |

### Vegetation

This rather variable community comprises wet woodland dominated by *Salix* spp. There is usually a low canopy (mean canopy height = 12.4 m,  $n = 32$ ) in which *Fraxinus excelsior* typically accompanies the willows while *Alnus glutinosa* and *Acer pseudoplatanus* are also frequent. In the diverse field layer *Rubus fruticosus* agg., *Hedera helix*, *Filipendula ulmaria*, *Angelica sylvestris*, *Urtica dioica* and *Dryopteris dilatata* are constants while frequently found plants include *Ranunculus repens*, *Galium aparine*, *Cardamine flexuosa*, *Agrostis stolonifera*, *Carex remota*, *Galium palustre*, *Chrysosplenium oppositifolium* and *Mentha aquatica*. The bryophyte layer is composed mostly of *Kindbergia praelonga*, *Brachythecium rutabulum* and *Hypnum cupressiforme*. Further variation is discussed under 'Sub-communities' below.

### Ecology

This community mainly occurs on wet gley soils but also on basin peats and well-drained mineral soils (mean organic content = 40.5%,  $n = 33$ ). It is found almost always on flat ground in the lowlands (mean slope = 0.5°,  $n = 33$ ; mean altitude = 51 m,  $n = 33$ ). Conditions are relatively base-rich and quite fertile.

### Sub-communities

Two quite distinct sub-communities have been described for this community. The *Salix fragilis* – *Calystegia sepium* sub-community (WL3Di) differs chiefly in the presence of one or more species of willow that are regarded as archaeophytes in Ireland (*Salix fragilis*, *Salix alba*, *Salix viminalis* or *Salix triandra*), although *Salix cinerea* is still frequent. The field layer is usually a dense tangle including *Calystegia sepium*, *Iris pseudacorus*, *Oenanthe crocata*, *Rumex sanguineus*, *Phalaris arundinacea*, *Valeriana officinalis* and *Solanum dulcamara*. This sub-community is rare in Ireland and restricted to periodically inundated lowland river islands and banksides. In the more common *Crataegus monogyna* – *Dryopteris dilatata* sub-community (WL3Dii), *Salix cinerea* is usually the only willow present and *Crataegus monogyna* sometimes occurs in a scanty understorey. The field layer differs in the occurrence of species less tolerant of inundation such as *Geum urbanum*, *Geranium robertianum*, *Dryopteris dilatata*, *Athyrium filix-femina* and *Circaea lutetiana*.

### Similar communities

Sub-community WL3Dii is related to the willow woodlands of WL3E and WL3F (c.f.)

### Records and distribution

#### Number of records (all)

|                   |    |
|-------------------|----|
| Clearly assigned: | 40 |
| Transitional:     | 17 |
| Total:            | 57 |

#### Number of records (mapped)

|            |    |
|------------|----|
| 2001-2015: | 50 |
| 1986-2000: | 7  |
| 1971-1985: | 0  |
| Pre-1971:  | 0  |
| Total:     | 57 |

#### Number of hectads (most recent records)

|            |    |
|------------|----|
| 2001-2015: | 38 |
| 1986-2000: | 3  |
| 1971-1985: | 0  |
| Pre-1971:  | 0  |
| Total:     | 41 |

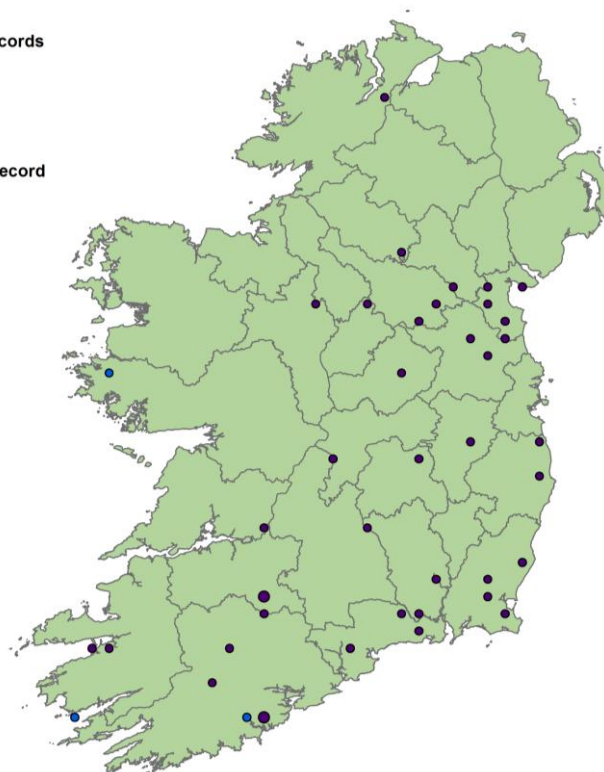
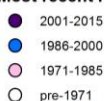
#### Number of hectads (all mapped records)

|            |    |
|------------|----|
| 2001-2015: | 38 |
| 1986-2000: | 4  |
| 1971-1985: | 0  |
| Pre-1971:  | 0  |

#### Number of records



#### Most recent record



### Synoptic table (n = 39)

| Species                        | Frequency<br>(from I-V) | Cover<br>min (med) max | Species                              | Frequency<br>(from I-V) | Cover<br>min (med) max |
|--------------------------------|-------------------------|------------------------|--------------------------------------|-------------------------|------------------------|
| <i>Rubus fruticosus</i> agg.   | V                       | 1-(3)-8                | <i>Acer pseudoplatanus</i>           | III                     | +- (3)-6               |
| <i>Hedera helix</i>            | V                       | 2-(4)-8                | <i>Plagiomnium undulatum</i>         | III                     | +- (2)-6               |
| <i>Kindbergia praelonga</i>    | V                       | +- (3)-7               | <i>Carex remota</i>                  | III                     | +- (2)-6               |
| <i>Salix cinerea</i>           | V                       | 5-(7)-9                | <i>Chrysosplenium oppositifolium</i> | III                     | +- (3)-8               |
| <i>Filipendula ulmaria</i>     | IV                      | 1-(3)-6                | <i>Rumex sanguineus</i>              | III                     | +- (2)-3               |
| <i>Angelica sylvestris</i>     | IV                      | 1-(2)-5                | <i>Galium palustre</i>               | III                     | 1-(2)-3                |
| <i>Fraxinus excelsior</i>      | IV                      | +- (4)-8               | <i>Mentha aquatica</i>               | III                     | +- (2)-4               |
| <i>Urtica dioica</i>           | IV                      | +- (2)-7               | <i>Frullania dilatata</i>            | II                      | +- (+)-1               |
| <i>Dryopteris dilatata</i>     | IV                      | +- (3)-5               | <i>Cardamine pratensis</i>           | II                      | +- (2)-4               |
| <i>Brachythecium rutabulum</i> | III                     | +- (2)-5               | <i>Eurhynchium striatum</i>          | II                      | 1-(3)-4                |
| <i>Ranunculus repens</i>       | III                     | +- (2)-5               | <i>Oenanthe crocata</i>              | II                      | 2-(3)-8                |
| <i>Galium aparine</i>          | III                     | +- (2)-3               | <i>Ulota bruchii/crispa</i>          | II                      | +- (+)-2               |
| <i>Cardamine flexuosa</i>      | III                     | +- (2)-5               | <i>Thamnobryum alopecurum</i>        | II                      | +- (2)-4               |
| <i>Hypnum cupressiforme</i>    | III                     | +- (2)-3               | <i>Athyrium filix-femina</i>         | II                      | 1-(3)-4                |
| <i>Agrostis stolonifera</i>    | III                     | 1-(3)-5                | <i>Circaea lutetiana</i>             | II                      | +- (2)-5               |
| <i>Lophocolea bidentata</i>    | III                     | +- (+)-3               | <i>Iris pseudacorus</i>              | II                      | 1-(3)-6                |
| <i>Geum urbanum</i>            | III                     | +- (2)-5               | <i>Thuidium tamariscinum</i>         | II                      | +- (2)-8               |
| <i>Geranium robertianum</i>    | III                     | +- (3)-7               | <i>Hypnum resupinatum</i>            | II                      | +- (1)-2               |
| <i>Alnus glutinosa</i>         | III                     | 3-(5)-8                | <i>Poa trivialis</i>                 | II                      | 2-(3)-7                |
| <i>Crataegus monogyna</i>      | III                     | +- (3)-4               | <i>Isoetium myosuroides</i>          | II                      | 1-(2)-3                |

#### Affinities

GHI: WN6 Wet willow-alder-ash woodland (54.5%) / WN5 Riparian woodland (33.3%) (n = 33)

ZM: Salicion cinereae / Salicion albae

EUNIS: F9.211 Western grey willow carrs / G1.1111 Western European white willow forests

NVC: W7a *Alnus glutinosa*-*Fraxinus excelsior*-*Lysimachia nemorum* woodland *Urtica dioica* sub-community (56.1%)

Annex I: 91E0 Residual alluvial forests\* (57.6%) (n = 33)

#### Proxy environmental data

Light: 5.9 Reaction: 6.1 Wetness: 7.0 Fertility: 5.5 Salinity: 0.1

#### Conservation value

This is quite a species-rich woodland community (total species/100 m<sup>2</sup> = 39.2, n = 33) with a reasonable bryophyte flora (bryophyte species/100 m<sup>2</sup> = 10.7, n = 33). Stands along rivers and lakes which are subject to periodic inundation qualify as EU Annex I habitat 91E0 Residual alluvial forests\*. These include stands of sub-community GL3Dii which are dominated by non-native willow species and might otherwise be deemed to be of lower conservation value.

#### Management

The main threats to these woodlands include changes to hydrological regimes, overgrazing by livestock (usually cattle), woodland clearance and invasion by non-native species such as *Impatiens glandulifera*.

#### Key references

Perrin, P.M., Martin, J.R., Barron, S.J., O'Neill, F.H., McNutt, K.E., Delaney, A. (2008) National Survey of Native Woodlands 2003-2008. Unpublished report submitted to National Parks & Wildlife Service

Synopsis version: V1.0

Synopsis date: December 2016

Synopsis author(s): P.M. Perrin





Photo 1. WL3D *Salix cinerea* – *Urtica dioica* woodland, Grove Island, Meath (S. Barron/P. Perrin, July 2005)



Photo 2. WL3D *Salix cinerea* – *Urtica dioica* woodland, Doonass Demesne, Clare (P. Perrin/G. Smith, August 2008)



## Appendix 4 - Interpretation Manual of EU Habitats definition of 91E0\*

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## 91E0

### \* Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion*, *Alnion incanae*, *Salicion albae*)

PAL.CLASS.: 44.3, 44.2 and 44.13

- 1) Riparian forests of *Fraxinus excelsior* and *Alnus glutinosa*, of temperate and Boreal Europe lowland and hill watercourses (44.3: *Alno-Padion*); riparian woods of *Alnus incanae* of montane and sub-montane rivers of the Alps and the northern Apennines (44.2: *Alnion incanae*); arborescent galleries of tall *Salix alba*, *S. fragilis* and *Populus nigra*, along medio-European lowland, hill or sub-montane rivers (44.13: *Salicion albae*). All types occur on heavy soils (generally rich in alluvial deposits) periodically inundated by the annual rise of the river (or brook) level, but otherwise well-drained and aerated during low-water. The herbaceous layer invariably includes many large species (*Filipendula ulmaria*, *Angelica sylvestris*, *Cardamine* spp., *Rumex sanguineus*, *Carex* spp., *Cirsium oleraceum*) and various vernal geophytes can occur, such as *Ranunculus ficaria*, *Anemone nemorosa*, *A. ranunculoides*, *Corydalis solida*.  
This habitat includes several sub-types: ash-alder woods of springs and their rivers (44.31 - *Carici remotae-Fraxinetum*); ash-alder woods of fast-flowing rivers (44.32 - *Stellario-Alnetum glutinosae*); ash-alder woods of slow-flowing rivers (44.33 - *Pruno-Fraxinetum*, *Ulmo-Fraxinetum*); montane grey alder galleries (44.21 - *Calamagrosti variaae-Alnetum incanae* Moor 58); sub-montane grey alder galleries (44.22 - *Equiseto hyemalis-Alnetum incanae* Moor 58); white willow gallery forests (44.13 - *Salicion albae*). The Spanish types belong to the alliance *Osmundo-Alnion* (Cantabric atlantic and southeast Iberia peninsula).
- 2) Plants: Tree layer - *Alnus glutinosa*, *Alnus incanae*, *Fraxinus excelsior*; *Populus nigra*, *Salix alba*, *S. fragilis*; *Betula pubescens*, *Ulmus glabra*; Herb layer - *Angelica sylvestris*, *Cardamine amara*, *C. pratensis*, *Carex acutiformis*, *C. pendula*, *C. remota*, *C. strigosa*, *C. sylvatica*, *Cirsium oleraceum*, *Equisetum telmateia*, *Equisetum* spp., *Filipendula ulmaria*, *Geranium sylvaticum*, *Geum rivale*, *Lycopus europaeus*, *Lysimachia nemorum*, *Rumex sanguineus*, *Stellaria nemorum*, *Urtica dioica*.
- 3) Corresponding categories  
United Kingdom classification: "W5 *Alnus glutinosa*-*Carex paniculata* woodland", "W6 *Alnus glutinosa*-*Urtica dioica* woodland" and "W7 *Alnus glutinosa*-*Fraxinus excelsior*-*Lysimachia nemorum* woodland".  
German classification: "43040401 Weichholzaeuwald mit weitgehend ungertörter Überflutungsdynamik", "43040402 Weichholzaeuwald ohne Überflutung", "430403 Schwarzerlenwald (an Fließgewässern)", "430402 Eschenwald (an Fließgewässern)", "430401 Grauerlenauwald (montan, Alpenvorland, Alpen).  
Nordic classification: "2234 *Fraxinus excelsior*-typ" and "224 Alskog".
- 4) Most of these forests are in contact with humid meadows or ravine forests (*Tilio-Acerion*). A succession towards *Carpinion* (*Primulo-Carpinetum*) can be observed.
- 5) **Brunet, J. (1991)**. Vegetation i Skånes alm- och askskogar. *Sven. Bot. Tidskr.* 85:377-384.

# Appendix C. Trail Camera Monitoring 2021 (Sweeney, 2021)



**Sweeney Consultancy**

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**CAMERA TRAP MONITORING OF A MAMMAL BURROW  
AT MORTARSTOWN, CO. CARLOW**

**September 2021**



## 1.0 Introduction

Sweeney Consultancy was contracted to monitor a mammal burrow, which appears to be an otter holt, at Mortarstown, using a camera trap. The location of this burrow is shown in Figure 1. The purpose of this monitoring is to determine whether this is an active holt or if any other mammals are using it.

Fig. 1: Location Map:



## 2.0 Methodology

As otter is a legally protected species, photography was carried out under Licence No. 182/2021, issued by the National Parks and Wildlife Service. A Bushnell HD Trail Camera was attached to a tree, 5m from the burrow on September 13, 2021 and left in place until September 21, 2021.

## 3.0 Results

No otters were photographed.

No mammals were photographed exiting the burrow.

A Pine Marten (*Martes martes*) was photographed outside the burrow twice on the night of September 13/14 (Photo 1).

**Photo 1: Pine Marten**



(Note: The time stamp on the camera was incorrectly set by 12 hours early)





A Fox (*Vulpes vulpes*) was photographed outside the burrow on the nights of September 13/14, September 16/17, September 17/18, and September 20/21 (Photo 2).

**Photo 2: Fox**



## 4.0 Conclusions

While the burrow appears to be an otter holt, it is not currently active and neither is it in use by any other mammal species.



# Appendix D. Invasive Non-native Species Reports

## D.1 Survey Report and Management Plan (Envirico, 2021)







# *Invasive Alien Species Management Plan*

Mortarstown WWTP, Green Road, Co. Carlow



May 2021

Prepared by Envirico on behalf of Atkins Ireland Limited

[www.envirico.com](http://www.envirico.com)

| Revision: 0         |                  |          |           |
|---------------------|------------------|----------|-----------|
| Action              | Personnel        | Company  | Date      |
| Report Prepared by: | Dr. Julie Larkin | Envirico | May, 2021 |
| Report Reviewed by: | Dr. Amanda Greer | Envirico | May, 2021 |

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## 1. INTRODUCTION

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Envirico have been engaged by Atkins Ireland Limited on behalf of Irish Water to carry out a Third Schedule invasive alien species survey and prepare an invasive species management plan for proposed works on the Mortarstown Waste Water Treatment Plant (hereafter the project). A walkover survey was conducted on the 22<sup>nd</sup> April, 2021. Two Third Schedule invasive alien species were recorded during the course of the survey – **Japanese Knotweed** (*Fallopia japonica*) and **Himalayan Balsam** (*Impatiens glandulifera*).

This invasive alien species management plan (IASMP) has been prepared in accordance with current Irish best practice guidelines such as ‘The Management of Noxious Weeds and Non-Native Invasive Plant Species on National Roads’ – NRA (2010); Best Practice for Control of Japanese Knotweed *Fallopia japonica*/Rhododendron *Rhododendron ponticum* – Inland Fisheries Ireland; Best Practice Management Guidelines Japanese Knotweed *Fallopia japonica*/Rhododendron *Rhododendron ponticum* – Invasive Species Ireland (2008); Irish Water Report Information and Guidance Document on Japanese knotweed Asset Strategy and Sustainability.

**1.1 Site Manager/Owner:** Irish Water

**1.2 Site Address:** Green Road,  
Carlow

**1.3 Site GPS Co-ordinates:** 52.819293, -6.940698

### 1.4 Site Description

The survey site is located on Green Road towards the southern extent of Carlow town. The survey area covered the Mortarstown Waste Water Treatment Plant on Green Road in Carlow including a section of a sheep pasture to the west of the plant and a section of woodland between the River Barrow and the R448 also to the west of the treatment plant (Drawing 1). The pumping station on the R448 opposite the junction with Green Road was also surveyed.

The planned works at the WWTP will involve the installation of an outflow water pipe through an open cut trench leading from the current location of the WWTP towards the River Barrow to the west of the plant. This trench is expected to be 10m wide and 7m deep. The proposed project will require a cofferdam and dry instream working area. This will require sheet piling in the river and on the banks of the River Barrow. The proposed outfall pipe construction methodology is trenching.





## 1.5 Survey Limitations

The Japanese Knotweed observed during the current survey has been treated previously. It is not known if this treatment was applied by personnel suitably certified and trained to treat Japanese Knotweed, therefore the risks associated with inappropriate treatment of Japanese Knotweed, e.g. dormancy, may apply.

## 1.6 Site Management Objectives and Threats to Objectives

The site management objectives, threats to achieving those objectives and the planned strategies for minimising these threats are outlined in Table 1.

Table 1. Site management objectives, threats and mitigation for these threats.

| Objective                                                                | Threat(s)                                                                                                                                                                                            | Mitigation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|--------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. To prevent the spread of invasive species as a result of these works. | Movement of equipment and personnel throughout areas contaminated with invasive species.<br><br>Digging amongst invasive species or areas containing propagules<br><br>Movement of contaminated clay | Before works begin, Invasive Species will be treated in accordance with the advice in this IASMP.<br><br>All machinery that is working in infested areas must be thoroughly washed down and certified as clean before exiting the exclusion zone.<br><br>All contaminated clay will be treated according to the procedures outlined in the IASMP<br><br>All personnel and equipment that enter an exclusion zone will be certified as clean before exiting.<br><br>Strict biosecurity protocols will be implemented, as outlined in the detailed Biosecurity Document.<br><br>All Japanese knotweed related works will be supervised by an appropriately qualified person. |
| 2. To eradicate all growth of Japanese Knotweed from the site            | Japanese knotweed growth poses a threat to the integrity of built structures within 7m                                                                                                               | All excavated Japanese knotweed and associated contaminated clay will be removed off-site to an authorised waste facility under licence from NPWS.<br><br>All Japanese knotweed related works and works within 7m of Japanese knotweed will be supervised by an appropriately qualified person.                                                                                                                                                                                                                                                                                                                                                                            |



|                                                                                            |                                                                                                                                                                                                                                     |                                                                                       |
|--------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| 3. To enable works to go ahead in a timely fashion without compromising objectives 1 or 2. | Works may be delayed due to the implementation of biosecurity protocols, licence applications, uncovering of hidden invasive species material, waste classification, on-site treatment of or removal of contaminated spoil offsite. | Delays will be minimised by following the protocols laid out in this management plan. |
|--------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|



## 2. ABOUT THE RECORDED INVASIVE ALIEN SPECIES

---

### 2.1 Japanese Knotweed (*Fallopia japonica*)

Japanese Knotweed (*Fallopia japonica*) was introduced to Europe by the horticultural activities of Philippe von Siebold, who plucked the plant from the side of a Japanese volcano in the 1840s. It is a fast growing, perennial, herbaceous plant, native to East Asia (Japan, northern China, Taiwan and Korea). In its home range, the plant is not a threat because a host of native predators, fungi and herbivorous insects keep it in check. However, outside Japan it is classified as one of the World's Worst Invasive Species (World Conservation Union). The date of its first introduction to Ireland is not known, but is believed to be in the mid to late 19<sup>th</sup> century.

Japanese Knotweed can grow >3m high, with young shoots in spring growing up to 10 - 30cm per day, quickly resulting in dense stands that shade out other species. The leaves are a distinctive shape with a tapered tip and a flat base (up to 18cm long) and the mature hollow stems have nodes and look somewhat like bamboo canes. The underground rhizome system can be vast, extending up to 3m deep and 7m horizontally from the nearest visible growth. Japanese Knotweed produces small cream or white flowers in late summer or early autumn. There are only female plants in the UK and Ireland so sexual reproduction is negligible; however, hybrids with related plants can be produced (e.g. Giant knotweed; Russian Vine) and are found occasionally.

Even without sexual reproduction, the plant spreads at a rapid rate by rhizome extension. New plants can also grow from tiny fragments of rhizome (as little as 0.7 grams) or stems, which means that traditional control methods such as cutting or strimming will actually further spread a knotweed infestation. Some of the most likely routes for knotweed spread are via our roads, rivers and railway lines as tiny fragments are dragged along these routes enabling them to quickly colonise new areas. Knotweed is also often spread by the movement of contaminated soils offsite and the improper disposal of the weed in garden clearings. It can grow on a wide range of soil types, pH and salinity; has the ability to withstand droughts, heat, cold, sulphurous soil; and is tolerant towards heavy metals. This hardiness ensures a wide distribution across habitat types.

Japanese Knotweed's massive rhizome system and vigorous growth can seriously damage walls, foundations, roads and buildings, including historic sites. The plant can also disrupt the integrity of man-made flood defense structures, increasing costs in repair and maintenance. Railway tracks, roads, pavements, and other constructions are also frequently affected.

In Ireland, Japanese Knotweed is classified as a High-Impact Invasive Species with a Risk Assessment Score of 20. It is listed in Part 1 of the Third Schedule of Statutory Instrument 477/2011 (Birds and Natural Habitats Regulations) and spoil contaminated with Japanese



Knotweed waste is classified as a vector material in Part 3 of the Third Schedule (see Section 3 for details of this legislation).

## **2.2 Himalayan Balsam (*Impatiens glandulifera*)**

Himalayan Balsam (AKA Policeman's Helmet) was first introduced to the British Isles as an ornamental plant in 1839. It has since spread at an average rate of 645km<sup>2</sup> per year. It is a tall (up to 2m), shallow-rooted, annual plant that flourishes in the riparian habitat (e.g. along river banks). It has lance shaped leaves with heavily serrated edges, arranged opposite each other. From around June onwards it produces many pinkish/purple, bonnet shaped flowers. These flowers are very distinctive, making identification easy once they are evident. The stem is jointed, hollow and easily broken.

Reproduction is by seed only. From July onwards, the plant may produce many seed-pods/capsules. These are up to 3.5cm long and each may contain 4 – 16 seeds that are expelled from the pod through an explosive action when the pod is moved. A single plant can produce up to 4,000 seeds, which can be launched up to 7m away from the parent plant. Seeds also float in water, making dispersal down-stream a simple matter, with upstream colonisation of up to 7m in a growing season possible. Seeds can survive in the soil for up to 18 months.

Himalayan Balsam thrives in moist, nutrient rich soil and is a frequent invader of river banks and disturbed soils. In many parts of Ireland, a near monoculture of Himalayan balsam exists along riverbanks. This leads to significant problems, as the shallow roots of this species do not hold the banks together as well as the roots of native species. In winter, when the plant has died, the banks are particularly vulnerable to erosion, leading to increased siltation in the water; reduced water quality; and reduced carrying capacity of the stream so an increased likelihood of flooding. Himalayan Balsam outcompetes native species by growing more quickly early in the season and so out-shading them. It is also known as a 'pollinator robber'. Himalayan Balsam produces copious quantities of nectar, attracting bees and other pollinators away from native species that require their services to reproduce.

Control of Himalayan Balsam can be effectively achieved by cutting or pulling it before it sets seed. Every plant must be cleared as even small plants up to 0.5m are capable of seeding. This process must be repeated later in the year as once the initial plants are removed, dormant seeds in the seed bank will begin to grow, and these will manage to set seed within the same season if they are not cut or removed. Once the plant has set seeds, extreme care must be taken not to disturb the seed pods in anyway, and physical control must involve carefully bagging the seed heads first in order to avoid spread.

In Ireland, Himalayan Balsam is classified as a High-Impact Invasive Species with a Risk Assessment Score of 18. It is also listed as an Invasive Species of European Union Concern.





### 3. INVASIVE ALIEN SPECIES LEGISLATION

The Invasive Species Ireland project identified Japanese Knotweed as one of the highest risk (most un-wanted) non-native invasive species in Ireland. There is strict legislation surrounding Japanese Knotweed in Ireland – namely under Irish Statutory Instrument 477/2011 and the Wildlife Acts (1976-2000). We have also ratified a number of international conventions that oblige the Government to address the issue of non-native invasive species, including the Convention on Biological Diversity, the Bern Convention and the International Plant Protection Convention.

#### ***Irish Statutory Instrument 477/2011***

The EC Birds and Natural Habitats Regulations introduced important legislation concerning invasive species in the Republic of Ireland. There is a total of thirty-four terrestrial and aquatic alien plant species currently listed in Part 1 of the Third Schedule (as amended by S.I. No. 355/2015), which is included in Table 2 below;

**Table 2. Third Schedule of S.I. 477/2011 as amended**

| <b>Common Name</b>       | <b>Scientific Name</b>                    |
|--------------------------|-------------------------------------------|
| American skunk-cabbage   | <i>Lysichiton americanus</i>              |
| A red alga               | <i>Grateloupia doryphora</i>              |
| Brazilian giant-rhubarb  | <i>Gunnera manicata</i>                   |
| Broad-leaved rush        | <i>Juncus planifolius</i>                 |
| Cape pondweed            | <i>Aponogeton distachyos</i>              |
| Cord-grasses             | <i>Spartina</i> (all species and hybrids) |
| Curly waterweed          | <i>Lagarosiphon major</i>                 |
| Dwarf eel-grass          | <i>Zostera japonica</i>                   |
| Fanwort                  | <i>Cabomba caroliniana</i>                |
| Floating pennywort       | <i>Hydrocotyle ranunculoides</i>          |
| Fringed water-lily       | <i>Nymphoides peltata</i>                 |
| Giant hogweed            | <i>Heracleum mantegazzianum</i>           |
| Giant knotweed           | <i>Fallopia sachalinensis</i>             |
| Giant-rhubarb            | <i>Gunnera tinctoria</i>                  |
| Giant salvinia           | <i>Salvinia molesta</i>                   |
| Himalayan balsam         | <i>Impatiens glandulifera</i>             |
| Himalayan knotweed       | <i>Persicaria wallichii</i>               |
| Hottentot-fig            | <i>Carpobrotus edulis</i>                 |
| Japanese knotweed        | <i>Fallopia japonica</i>                  |
| Large-flowered waterweed | <i>Egeria densa</i>                       |
| Mile-a-minute weed       | <i>Persicaria perfoliata</i>              |
| New Zealand pigmyweed    | <i>Crassula helmsii</i>                   |
| Parrot's feather         | <i>Myriophyllum aquaticum</i>             |
| Rhododendron             | <i>Rhododendron ponticum</i>              |
| Salmonberry              | <i>Rubus spectabilis</i>                  |
| Sea-buckthorn            | <i>Hippophae rhamnoides</i>               |



|                     |                                                          |
|---------------------|----------------------------------------------------------|
| Spanish bluebell    | <i>Hyacinthoides hispanica</i>                           |
| Three-cornered leek | <i>Allium triquetrum</i>                                 |
| Wakame              | <i>Undaria pinnatifida</i>                               |
| Water chestnut      | <i>Trapa natans</i>                                      |
| Water fern          | <i>Azolla filiculoides</i>                               |
| Water-primrose      | <i>Ludwigia</i> (all species)                            |
| Waterweeds          | <i>Elodea</i> (all species except <i>E. canadensis</i> ) |
| Wireweed            | <i>Sargassum muticum</i>                                 |

Article 49 prohibits the introduction, breeding, release or dispersal of certain species; and Article 50 prohibits dealing in and keeping certain species.

**Article 49 (2)** “Save in accordance with a licence granted under paragraph (7), any person who plants, disperses, allows or causes to disperse, spreads or otherwise causes to grow in any place specified in relation to such plant in the third column of Part 1 of the Third Schedule, any plant which is included in Part 1 of the Third Schedule, shall be guilty of an offence.”

Article 49 (3) states that you can defend against allegations that you committed an offence under Article 49 (1) or (2) by proving that you took all reasonable steps and exercised all due diligence to avoid committing the offence:

**Article 49 (3)** “Subject to paragraph (4), it shall be a defence to a charge of committing an offence under paragraph (1) or (2) to prove that the accused took all reasonable steps and exercised all due diligence to avoid committing the offence.

**Article 50 (2)** “Save in accordance with a licence granted under paragraph (7), a person shall be guilty of an offence if he or she imports or transports –

(a) an animal or plant listed in Part 1 or Part 2 of the Third Schedule

(b) anything from which an animal or plant referred to in Part 2 of the Third Schedule can be reproduced or propagated, or

(c) a vector material listed in Part 3 of the Third Schedule,

into or in or to any place in the State specified in relation to such an animal or plant or vector material in relation to that animal or plant or vector material in the third column of the Third Schedule.”

The Wildlife Amendment Act (2000) of ***The Wildlife Act (1976)*** made it an offence to cause an exotic species of flora to grow in the wild anywhere in the state:



“Any person who plants or otherwise causes to grow in a wild state in any place in the State any (exotic) species of flora, or the flowers, roots, seeds or spores of flora, otherwise than under and in accordance with a licence granted in that behalf by the Minister shall be guilty of an offence.”

### **EU Regulation 1143/2014**

EU Regulation 1143/2014 on invasive alien species entered into force on 1 January 2015. It provides for a set of measures to be taken across the EU in relation to invasive alien species included on a list of Invasive Alien Species of Union concern. The list of invasive alien plant species can be seen in Table 3 below;

**Table 3. Plants listed as Invasive Alien Species of Union Concern (EU Regulation 1143/2014)**

| Scientific name                    | English name                | Entered into List |
|------------------------------------|-----------------------------|-------------------|
| <i>Acacia saligna</i>              | Golden wreath wattle        | 2019              |
| <i>Ailanthus altissima</i>         | Tree of heaven              | 2019              |
| <i>Alternanthera philoxeroides</i> | Alligator weed              | 2017              |
| <i>Andropogon virginicus</i>       | Broomsedge bluestem         | 2019              |
| <i>Asclepias syriaca</i>           | Milkweed                    | 2017              |
| <i>Baccharis halimifolia</i>       | Eastern baccharis           | 2016              |
| <i>Cabomba caroliniana</i>         | Green cabomba               | 2016              |
| <i>Cardiospermum grandiflorum</i>  | Balloon vine                | 2019              |
| <i>Cortaderia jubata</i>           | Purple pampas grass         | 2019              |
| <i>Ehrharta calycina</i>           | Perennial veldtgrass        | 2019              |
| <i>Eichhornia crassipes</i>        | Water hyacinth              | 2016              |
| <i>Elodea nuttallii</i>            | Nuttall's waterweed         | 2017              |
| <i>Gunnera tinctoria</i>           | Chilean rhubarb             | 2017              |
| <i>Gymnocoronis spilanthoides</i>  | Spadeleaf plant             | 2019              |
| <i>Heracleum mantegazzianum</i>    | Giant hogweed               | 2017              |
| <i>Heracleum persicum</i>          | Persian hogweed             | 2016              |
| <i>Heracleum sosnowskyi</i>        | Sosnowski's hogweed         | 2016              |
| <i>Humulus scandens</i>            | Japanese hop                | 2019              |
| <i>Hydrocotyle ranunculoides</i>   | Floating pennywort          | 2016              |
| <i>Impatiens glandulifera</i>      | Himalayan balsam            | 2017              |
| <i>Lagarosiphon major</i>          | Curly waterweed             | 2016              |
| <i>Lespedeza cuneata</i>           | Chinese bushclover, sericea | 2019              |
| <i>Ludwigia grandiflora</i>        | Water primrose              | 2016              |
| <i>Ludwigia peploides</i>          | Floating primrose           | 2016              |
| <i>Lygodium japonicum</i>          | Vine-like fern              | 2019              |
| <i>Lysichiton americanus</i>       | American skunk cabbage      | 2016              |
| <i>Microstegium vimineum</i>       | Japanese stiltgrass         | 2017              |
| <i>Myriophyllum aquaticum</i>      | Parrot's feather            | 2016              |
| <i>Myriophyllum heterophyllum</i>  | Broadleaf watermilfoil      | 2017              |
| <i>Persicaria perfoliata</i>       | Asiatic tearthumb           | 2016              |
| <i>Parthenium hysterophorus</i>    | Whitetop weed               | 2016              |



|                                            |                             |      |
|--------------------------------------------|-----------------------------|------|
| <i>Pennisetum setaceum</i>                 | Crimson fountaingrass       | 2017 |
| <i>Prosopis juliflora</i>                  | Mesquite                    | 2019 |
| <i>Pueraria montana</i> var. <i>lobata</i> | Kudzu vine                  | 2016 |
| <i>Salvinia molesta</i>                    | Giant salvinia, kariba weed | 2019 |
| <i>Triadica sebifera</i>                   | Chinese tallowtree          | 2019 |

**Table 4.** Animals listed as Invasive Alien Species of Union Concern (EU Regulation 1143/2014)

| Scientific name                                 | English name               | Entered into List |
|-------------------------------------------------|----------------------------|-------------------|
| <i>Acridotheres tristis</i>                     | Common or Indian myna      | 2019              |
| <i>Alopochen aegyptiaca</i>                     | Egyptian goose             | 2017              |
| <i>Arthurdendyus triangulatus</i>               | New Zealand flatworm       | 2019              |
| <i>Callosciurus erythraeus</i>                  | Pallas's squirrel          | 2016              |
| <i>Corvus splendens</i>                         | Indian house crow          | 2016              |
| <i>Eriocheir sinensis</i>                       | Chinese mitten crab        | 2016              |
| <i>Herpestes javanicus</i>                      | Small Asian mongoose       | 2016              |
| <i>Lepomis gibbosus</i>                         | Pumpkinseed                | 2019              |
| <i>Lithobates catesbeianus</i>                  | American bullfrog          | 2016              |
| <i>Muntiacus reevesi</i>                        | Muntjac deer               | 2016              |
| <i>Myocastor coypus</i>                         | Coypu                      | 2016              |
| <i>Nasua nasua</i>                              | South American coati       | 2016              |
| <i>Nyctereutes procyonoides</i>                 | Raccoon dog                | 2017              |
| <i>Ondatra zibethicus</i>                       | Muskrat                    | 2017              |
| <i>Orconectes limosus</i>                       | Spiny-cheek crayfish       | 2016              |
| <i>Orconectes virilis</i>                       | Virile (northern) crayfish | 2016              |
| <i>Oxyura jamaicensis</i>                       | Ruddy duck                 | 2016              |
| <i>Pacifastacus leniusculus</i>                 | Signal crayfish            | 2016              |
| <i>Perccottus glenii</i>                        | Amur sleeper               | 2016              |
| <i>Plotosus lineatus</i>                        | Striped eel catfish        | 2019              |
| <i>Procambarus clarkii</i>                      | Red swamp crayfish         | 2016              |
| <i>Procambarus fallax</i> f. <i>virginialis</i> | Marbled crayfish           | 2016              |
| <i>Procyon lotor</i>                            | Raccoon                    | 2016              |
| <i>Pseudorasbora parva</i>                      | Topmouth gudgeon           | 2016              |
| <i>Sciurus carolinensis</i>                     | Grey squirrel              | 2016              |
| <i>Sciurus niger</i>                            | Bryant's fox squirrel      | 2016              |
| <i>Tamias sibiricus</i>                         | Siberian chipmunk          | 2016              |
| <i>Threskiornis aethiopicus</i>                 | Sacred Ibis                | 2016              |
| <i>Trachemys scripta</i>                        | Red eared slider           | 2016              |
| <i>Vespa velutina nigrithorax</i>               | Asian hornet               | 2016              |





### **Japanese Knotweed Disposal**

In order to transport Japanese knotweed from one location to another, a licence must first be obtained from the National Parks and Wildlife Service.

A licence application must include:

- As much information as possible on the removal, transportation and treatment of the species in question
- A detailed description of the biosecurity measures that will be in place
- A copy of the Knotweed Management plan
- Details of the timeframe for carrying out the work

Under the **Waste Management (Facility, Permit and Registration) Regulations 2007**, Japanese knotweed waste can only be stored or disposed of at a licenced waste facility. The waste must only be transported offsite by a licenced haulier, and the licenced waste facility must be notified in advance of the nature of the waste and have agreed to accept the waste material.



## 4. SURVEY FINDINGS

A walkover survey was conducted on 22<sup>nd</sup> April 2021. This survey confirmed the presence of two Third Schedule S.I. 477/2011 invasive alien species, Japanese Knotweed and Himalayan Balsam. Both of these species were recorded from the banks of the River Barrow, within a Special Area of Conservation (River Barrow and River Nore SAC (site code 002162)).

### 4.1 On-site findings

#### 4.1.1 Japanese Knotweed

A single stand of Japanese Knotweed was recorded within the survey area (see Appendix I – Drawings). This infestation was given a unique identifier number (JK01). Details of this stand are given in Table 5.

**JK01** is located within a woodland area between the River Barrow and the R448. This stand is showing signs of being treated in the past, with the majority of canes broken and degraded, however, there are numerous areas where new growth is visible. This stand is very extensive and well established with at least 60 old crowns observed within the area. These crowns have been treated in the past with very little new growth observed from them, however, the extensive rhizome systems associated with these crowns are still viable with new Japanese Knotweed shoots ascending a short distance from the crowns. This Japanese Knotweed infestation is also present at the boundary of the adjacent residential property.

Table 5. Details of each stand of Japanese Knotweed within the survey area

| ID                                                                        | GPS Co-ords          | Length (m) | Width (m) | Growth Stage | Avg. Stem Height | Max. Stem Diameter | Notes              |
|---------------------------------------------------------------------------|----------------------|------------|-----------|--------------|------------------|--------------------|--------------------|
| JK01                                                                      | 52.820473, -6.944361 | 49         | 30        | Viable       | <1m              | 1-2cm              | Previously treated |
| Total above ground coverage of Japanese Knotweed: c. 1454m <sup>2</sup> * |                      |            |           |              |                  |                    |                    |

\*Areas may differ from length by width due to irregular polygon shapes

#### 4.1.2 Himalayan balsam

A single stand of Himalayan balsam (**HB01**) was recorded from the survey area. This area was within the woodland between the R448 and the River Barrow and also in the footprint of JK01. It was located between the boundary of the adjacent residential property and the slope down towards the River. Numerous, small Himalayan Balsam plants were observed within the area with more plants likely to emerge as the growing season develops.



**Table 6 Details of each stand of Himalayan Balsam within the survey area**

| ID                                                                              | GPS Co-ordinate      | Length (m) | Width (m) | Growth Stage | Height (m) | Notes |
|---------------------------------------------------------------------------------|----------------------|------------|-----------|--------------|------------|-------|
| HB01                                                                            | 52.316373, -6.459283 | 14         | 16        | In leaf      | <0.5       | N/A   |
| Total above ground coverage of <i>Himalayan Balsam</i> : c. 190m <sup>2</sup> * |                      |            |           |              |            |       |

\*Areas may differ from length by width due to irregular polygon shapes



## 5. MANAGEMENT PLAN

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### 5.1 Japanese Knotweed

#### 5.1.1. Summary

The Japanese Knotweed on-site will be disturbed as a result of the planned works. This disturbance will occur during excavations for the placement of the WWTP outflow pipe. A very large quantity of material contaminated with Japanese knotweed (between 3,960m<sup>3</sup> and 8,316m<sup>3</sup>) will have to be excavated entirely and moved off-site as preparation for the laying of this pipe. Due to the quantity of contaminated material that would have to be excavated and removed off-site during the works, if it is possible at this planning stage to relocate the pipe to avoid disturbance of the Japanese knotweed, this would be the preferred solution. In the event that disturbance within 7m of the knotweed stands *can* be avoided, the recommendation will be to treat the knotweed in-situ with an aquatic-approved herbicide.

Below, we have provided details of the different options available if the pipe cannot be re-located. These options are listed in order of cost, from least expensive to most expensive.

#### 5.1.2. Management Options for Japanese Knotweed

##### (A) In-Situ Herbicide Treatment

**Summary:** The knotweed is left in-situ and treated with an appropriate herbicide. This treatment is repeated in accordance with best-practice and the infestation monitored until there has been no regrowth observed for a minimum of two growing seasons. This is the preferred option for eradicating Japanese Knotweed as it is the most cost-effective and environmentally friendly control method.

**Suitability for the Project:** The current works plan does not allow for the knotweed to remain in-situ as JK01 will be directly disturbed as part of the works. In the event that the works plan changes i.e. the location of the pipe is moved to avoid disturbance of the Japanese knotweed, this would be the preferred control method.

##### (B) Excavation and Removal to Bund/Stockpile

**Summary:** Knotweed contaminated material is excavated from its current location and removed to a portion of the site where it is spread to a depth of ideally up to 0.5m but up to 1m is acceptable. Any regrowth that appears is treated with herbicide application over time and monitored until a minimum of two years without regrowth.

Given the width (10m), depth (7m) and length (approx. 75m) of the trench excavation a total of approx. 5,250m<sup>3</sup> will have to be excavated from the proposed trench area and





stored elsewhere onsite. Much or all of this material may be contaminated with Japanese Knotweed rhizome.

**Suitability for the Project:** There is a possibility that this material could be stored within the green areas proposed for the Waste Water Treatment Plant site; however, there is a sizeable quantity of material which would require a very large area for it to be stored in. It is not known at this point if such an area would be available on-site. In addition, material cannot be stored within a flood plain or any area likely to flood. This option requires on-going herbicide treatment of the bund over a number of years.

#### (C) Excavation and On-Site Burial

**Summary:** Knotweed contaminated material is buried on the site either (a) with a minimum of 5m clean back fill placed on-top, or (b) encapsulated in a fully sealed root barrier membrane with a minimum of 2m clean back fill placed on-top. The burial location must be marked on the property deeds to prevent future accidental damage to the cell.

Given the width (10m), depth (7m) and length (approx. 75m) of the trench excavation a total of approx. 5,250m<sup>3</sup> will have to be excavated from the proposed trench area. Much or all of this material may be contaminated with Japanese Knotweed rhizome.

**Suitability for the Project:** There is a possibility that this material could be stored within the green areas within the Waste Water Treatment Plant site, however, it is a sizeable quantity of material which would require a very large excavation for it to be buried in. It is not known at this point if such an area would be available on-site. In addition, material cannot be stored within a flood plain or any area likely to flood. This option carries the restrictions that excavations cannot happen in the area of the cell location in the future.

#### (D) Excavation and On-Site Screening

**Summary:** Knotweed contaminated material is excavated and passed through a screening plant where knotweed material is hand-picked out from a conveyor line. The resulting material is then spread to a depth of ideally up to 0.5m but up to 1m is acceptable. Any regrowth that appears is treated with herbicide application overtime and monitored until a minimum of two years without regrowth has been observed. Given the width (10m), depth (7m) and length (approx. 75m) of the trench excavation a total of approx. 5,250m<sup>3</sup> will have to be excavated from the proposed trench area. Much or all of this material may be contaminated with Japanese Knotweed rhizome.

From PCA Code of Practice – Management of Japanese Knotweed, April 2018, regarding soil screening: *“This soil will then need to be monitored for at least two growing seasons and any regrowth treated with herbicide as per the stockpiling treatment above”*.



**Suitability for the Project:** There is a possibility that this material could be stored within the green areas within the Waste Water Treatment Plant site, however, it is quite a sizeable quantity of material which would require a very large area for it to be screened and stored. Note: material cannot be stored within a flood plain or any area likely to flood. This method still involves a minimum of two years of monitoring before the site is considered free of knotweed.

#### (E) Excavation and Off-Site Disposal

**Summary:** All knotweed contaminated material is excavated in full and loaded into suitably licenced haulage trucks. The trucks are filled to within no more than 300mm of the top and are securely covered before they leave the site. Any movement of knotweed contaminated material off-site is subject to a transport licence from the National Parks and Wildlife Service. Given the width (10m), depth (7m) and length (approx. 75m) of the trench excavation a total of approx. 5,250m<sup>3</sup> will have to be excavated from the proposed trench area. Much or all of this material may be contaminated with Japanese Knotweed rhizome.

#### **Suitability for the Project:**

At this scoping stage of the project, due to the size of the area needed to either stockpile or bury the excavated material on-site, it is probable that off-site disposal will be the only viable method of handling excavated material contaminated with Japanese knotweed. A number of points, however, should be taken into account when considering this option:

- Removal off-site carries an additional biosecurity risk to the nation as the material has to be transported along Ireland's road network.
- Removing material off-site has further reaching environmental impacts as this material will be either placed into Irish landfill, using valuable landfill capacity, or loaded onto a ship and transported to the Netherlands for incineration.
- Removal off-site is considered the last resort option according to best-practice knotweed management guidelines, only to be undertaken when other options have been discounted as unsuitable.
- This option is extremely expensive.

From PCA Code of Practice – Management of Japanese Knotweed, April 2018: *“Disposal to landfill reduces valuable landfill capacity and needs haulage (which damages the environment and increases the risk of Japanese Knotweed spreading) and in the long term unsustainable. As such, disposal to landfill should only be considered as last resort when Japanese Knotweed cannot be suitably disposed of on-site”.*

#### **Excavation and Off-Site Disposal Protocol**

- An exclusion zone must be set up 7m around the knotweed.



- If it is necessary to gain a better approximation of the volumes of material to be removed off-site, a test trenching programme can be carried out by an invasive species specialist prior to the excavation works.
- A representative sample of the soil and stone material to be removed off-site must be sent to an appropriate laboratory for Waste Acceptance Criteria (WAC) analysis before works commence.
- A NPWS transport license and the results of the WAC analysis must be received and submitted to the receiving waste facility before excavation works commence.
- If there is a significant amount of above ground knotweed material to be removed, this will have to be disposed of separately as vegetation to an appropriately licensed waste facility that has been notified of the type of waste. This will require a separate NPWS license.
- All site personnel will receive biosecurity training before they begin work on the site, including instruction on Japanese knotweed identification (see **Appendix I – Japanese Knotweed Identification Sheet**).
- The knotweed vegetation will be cut back and placed into tonne bags to await collection. Other vegetation can be cut back and disposed of at any green waste facility.
- A loading area, and clean-down area must be set up before any trucks arrive on-site or any work takes place within 7m of the knotweed (see Biosecurity Protocols – Section 6).
- Designated haulage routes must be in place before trucks arrive on-site.
- All trucks that enter the site will be guided along the designated haulage route onto the loading area.
- Prior to excavation, consideration should be given to the possible ecological impacts and biosecurity risk of excavating the river bank. In order to avoid knotweed rhizome and silt from entering the watercourse during the excavation works, these will need to be dry works, and the river diverted away from the works for the duration.
- The knotweed will be carefully excavated and loaded into the awaiting truck.
- The haulage truck will be filled to no more than 20cm from the top.
- All haulage trucks will be covered, and will have their covers checked as in place before they are allowed to exit the site.
- All haulage trucks will be cleaned down in a designated clean down area, and certified as clean before they exit the site.
- All machinery, equipment and personnel that have been in contact with Japanese knotweed contaminated material, or have entered the exclusion zone, will be subject to strict biosecurity protocols as outlined in Section 6.
- These works will be supervised continuously by an Invasive Species Clerk of Works, in order to ensure strict adherence to biosecurity protocols. This is paramount, as any lapse in biosecurity could spread Japanese knotweed rhizome across the site.



- A daily sign-off sheet must be maintained that declares whether all works were completed in accordance with the IASMP, if biosecurity protocols were adhered to at all times, and any incidents or occurrences of note.
- Following completion of the knotweed removal works, the riverbank is likely to require reinstatement to protect against flooding and erosion.
- Following satisfactory completion of the works, a completion certificate should be issued to the client.
- Follow-up monitoring of the site for Japanese knotweed must be carried out for a minimum of two consecutive years with no regrowth.

## 5.2 Himalayan Balsam

### 5.2.1 Recommended Site Management – Himalayan Balsam

As HB01 is a small infestation with a low number of plants we recommend that Himalayan Balsam is pulled by hand prior to the plant setting seed and the stem severed to prevent regrowth. The Himalayan Balsam present on site can be controlled by hand-pulling twice annually commencing in May-June 2021. Plants that are pulled must be broken near the root in order to prevent re-rooting and can be left to compost on-site. This method will not impact on the sensitive habitats of the River Barrow and River Nore Special Area of Conservation and is highly effective when managed properly.

The control must be repeated in autumn as plants that grow from the seed bank during the summer may become capable of seeding before the end of the year if they are left in situ, thereby replenishing the seedbank. The Himalayan Balsam seedbank is viable for 18 months. Therefore, if control is carried out effectively there should be no plants left in the original seedbank following a two-year programme. However, because reintroduction is possible and indeed likely from plants further upstream, an ongoing annual monitoring should be introduced to keep the area clear.





## 6. BIOSECURITY PROTOCOLS

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Persons/machinery entering or working within an area infested with an invasive alien species must take certain precautions to prevent the spread of that species. These guidelines must be strictly adhered to at all times.

### 6.1 Exclusion Zones

- Exclusion zones must be clearly marked or fenced off in order to prevent accidental incursion.

### 6.2 Machinery/Equipment/Haulage trucks

- All equipment and machinery to enter an exclusion zone must be thoroughly clean before entering.
- The number of machines that enter exclusion zones or come into contact with contaminated material should be kept to a minimum.
- A designated biosecurity area(s) lined with appropriate geo-textile will be set-up within the exclusion zone(s). A power washer and stiff bristled brushes will be made available at these locations.
- In the biosecurity area, all equipment and machinery must be thoroughly cleaned before exiting the exclusion zone, paying particular attention to any part of the machinery or equipment that may have come into contact with an invasive species or contaminated clay e.g. tracks/tyres, bucket, machine arm, wheel arches etc.
- All equipment and machinery must be certified as clean by the Invasive Species Clerk of Works before they are removed from the exclusion zone.
- Any material that is washed off equipment and machinery will be added to the contaminated material to be managed appropriately.
- Personnel are at all times to be mindful of the threat posed by the spread of Japanese knotweed and to take all possible precautions to ensure that their actions do not result in the accidental movement of contaminated material.

### 6.3 Ground Personnel

- All PPE to enter an exclusion zone must be thoroughly clean before entering.
- Before leaving an infested area, individuals must thoroughly inspect their clothing, PPE, any equipment and their footwear for rhizomes, or other plant fragments that may be stuck on.



- A designated biosecurity area(s) lined with appropriate geo-textile will be set-up within each exclusion zone. A bucket with soapy water, a hoofpick and a stiff bristled brush will be situated at these locations.
- In the biosecurity area, all PPE and equipment must be thoroughly cleaned before personnel leave the exclusion zone.
- All personnel should use a hoofpick to thoroughly clean the treads of their footwear. All footwear must be thoroughly cleaned before leaving the exclusion zone.
- All PPE, other equipment and machinery, clothing and footwear must be thoroughly cleaned with soapy water and a stiff bristled brush before leaving an infested zone.
- PPE (incl. boots) and equipment should be certified as clean by the Invasive Species Clerk of Works before they are removed from the exclusion zone.
- Any material that is washed off equipment and machinery will be added to the contaminated material to be managed appropriately.
- Personnel are at all times to be mindful of the threat posed by the spread of Japanese knotweed and to take all possible precautions to ensure that their actions do not result in the accidental movement of contaminated material.



## 7. CODES OF PRACTICE/SOURCES OF INFORMATION FOR INVASIVE KNOTWEED SPECIES

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### Ireland

- Invasive Species Ireland Horticultural Code of Good Practice (<http://invasivespeciesireland.com/wp-content/uploads/2010/07/Horticulture-Code-Final.pdf>)
- National Roads Authority – The Management of Noxious Weeds and Non-Native Invasive Plant Species on National Roads (<http://www.tii.ie/technical-services/environment/construction/Management-of-Noxious-Weeds-and-Non-Native-Invasive-Plant-Species-on-National-Road-Schemes.pdf>)
- Invasive Species Ireland Japanese Knotweed Best Practice Management Guidelines (withdrawn since 1<sup>st</sup> Nov, 2016).
- Inland Fisheries Ireland – Best Practice Guidelines for the Control of Japanese Knotweed (<http://invasivespeciesireland.com/wp-content/uploads/2012/01/Best-practice-control-measures-for-Japanese-knotweed.pdf>)
- National Biodiversity Data Centre Invasive Species (<http://www.biodiversityireland.ie/projects/invasive-species/>)
- Invasive Species Ireland Website (<http://invasivespeciesireland.com/>)
- Sligo Institute of Technology Alien Species ([http://staffweb.itsligo.ie/staff/dcotton/Alien\\_Species.html](http://staffweb.itsligo.ie/staff/dcotton/Alien_Species.html))
- Online Atlas of the British and Irish Flora (<http://www.brc.ac.uk/plantatlas/>) – *UK also*

### UK

- Property Care Association Code of Practice for the Management of Japanese Knotweed ([http://www.property-care.org/wp-content/uploads/2015/04/Code-of-Practice-for-the-Management-of-Japanese-knotweed\\_v2.7.pdf](http://www.property-care.org/wp-content/uploads/2015/04/Code-of-Practice-for-the-Management-of-Japanese-knotweed_v2.7.pdf))
- Environment Agency – The Knotweed Code of Practice Version 3 (withdrawn since 11<sup>th</sup> Jul, 2016).
- Royal Institute of Chartered Surveyors – Japanese Knotweed and Residential Property (<http://www.rics.org/uk/knowledge/professional-guidance/information-papers/japanese-knotweed-and-residential-property-1st-edition/>)
- Department for Environment, Food and Rural Affairs Horticultural Code of Practice (<http://www.botanicgardens.ie/gspc/pdfs/defra%20code%20of%20practice.pdf>)
- GB Non-Native Species Secretariat (<http://www.nonnativespecies.org>)



## 8. ABOUT ENVIRICO

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Envirico are an Irish ecological company that specialise in invasive species monitoring and control. We tackle invasive alien species found in domestic, commercial and amenity sites in terrestrial, riparian and freshwater habitats.

Our qualifications include:

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- Ph.D. Ecology/Microbiology
- MSc Aquatic Ecology
- PCA Certified Surveyor of Japanese Knotweed
- PA1 – Safe use of chemicals
- PA6A – Operating hand-held pesticide equipment
- PA6AW – Operating hand-held applicators to apply pesticides near water
- PA6INJ – Operating hand-held pesticide injection equipment
- PA6MC – Operating other hand-held applicators
- Registered Professional Pesticide User of Pesticides
- SOLAS Safe Pass Certified
- CSCS Personnel
- PTS Certified
- Traffic Management
- HSE Commercial Divers
- National Powerboat Certificate (Level 2)
- LANTRA Certified Trainers

Our services include:

---

- Site-Specific, Best-Practice Management Plans
- Site Excavation and Management
- Chemical Control
- Post-Treatment Monitoring
- Completion Certificate
- Habitat Restoration
- LANTRA Certified Training in Biosecurity and Identification















Figure 1 New growth within JK01



Figure 2 Dead canes within JK01





Figure 3 One of the numerous Japanese Knotweed crowns within JK01



Figure 4 New growth of Japanese Knotweed within JK01 near the slope down towards the river







Figure 5 Himalayan balsam plants within HB01



## JAPANESE KNOTWEED IDENTIFICATION SHEET



Rhizomes are bright orange when freshly cut



Canes have regular nodes like bamboo. May be purple speckled



Crown at base of canes





## Himalayan Balsam Identification Sheet



## **D.2      Management & Biosecurity Plan (INVAS, 2026)**







## Invasive Alien Plant Species Management & Biosecurity Plan

WwTP, Mortarstown, Carlow.



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| Client                              |           |                 | Project             |               |              |
|-------------------------------------|-----------|-----------------|---------------------|---------------|--------------|
| AtkinsRéalis Infrastructure Ireland |           |                 | Mortarstown, Carlow |               |              |
| Ver                                 | Date      | Details         | Prepared by         | Checked by    | Approved by  |
| 1                                   | 4/11/2025 | Management Plan | Tom Donovan         | Noel McCarthy | AtkinsRéalis |
| 2                                   | 5/12/2025 |                 | Tom Donovan         | Noel McCarthy | AtkinsRéalis |
| 3                                   | 29/1/2026 |                 | Tom Donovan         | Noel McCarthy | AtkinsRéalis |

*Cover Photo: Japanese knotweed*

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## 1. INTRODUCTION

At the request of AtkinsRéalis Infrastructure Ireland, INVAS Biosecurity (INVAS) was commissioned to prepare a management and biosecurity plan to facilitate the safe and biosecure development of the Waste Water Treatment Plant at Mortarstown, Carlow.

### 1.1. Objectives

For the purposes of this document, biosecurity refers to all practical measures used to manage and prevent the introduction and spread of Invasive Alien Plant Species (IAPS). Three IAPS have been recorded on the Mortarstown outfall site to the west of the Kilkenny Road, viz, Japanese knotweed (*Reynoutria japonica*), Himalayan balsam (*Impatiens glandulifera*) and the aquatic Nuttall's waterweed (*Elodea nuttallii*). Small stands of Three-Cornered Leek (*Allium triquetrum*) were recorded to the east of the Kilkenny Road.

A number of high impact aquatic and riparian Invasive Alien Species (IAS) are currently present in Ireland, and most are continuing to spread aggressively. Prominent among the terrestrial IAPS are: Japanese knotweed (*Reynoutria japonica*), Giant knotweed (*Reynoutria sachalinensis*), Bohemian knotweed (*Reynoutria x bohemica*), Giant rhubarb (*Gunnera tinctoria*), Giant hogweed (*Heracleum mantegazzianum*), Rhododendron (*Rhododendron ponticum*), Himalayan balsam (*Impatiens glandulifera*) and Nuttall's waterweed (*Elodea nuttallii*)

### 1.2. National and European legislation concerning invasive alien species.

Legal Requirements and Implications for Management Japanese knotweed and Himalayan balsam are all subject to restrictions under SI374/2025, being listed in the First Schedule (Part 1) of this legislative Act. Japanese knotweed and, Himalayan balsam are also contained on the list of Union concern in the Invasive Alien Species (IAS) Regulation (EU Regulation (1143/2014)) and states that management actions must be taken to eradicate Japanese knotweed, Himalayan balsam. This EU Regulation entered into force on 1st January, 2015. Central to the legislation is the establishment, and regular updating, of a list of IAS considered to be of Union concern ('the Union list'). The placing of a species on the Union list activates a number of obligations on Member States (MS) regarding those species (e.g. "Within 18 months of an IAS being included on the Union



list, MS shall have in place effective management measures for those invasive alien species of Union concern...”. Member States are required to take action on pathways of unintentional introduction, take measures for early detection and rapid eradication of these species, and to manage species that are already widely spread in their territory.

The ecological effects of IAS are often irreversible and, once established, they are extremely difficult and costly to control and eradicate; hence, the urgent need to prevent their introduction and spread. Prevention is clearly more cost-effective and less environmentally damaging than long-term containment, control or eradication. The most effective measure to reduce introductions and halt spread of IAS in aquatic situations is to promote and implement good biosecurity practice.

Globally, IAS are regarded as one of the biggest causes of biodiversity loss next to climate change. The environmental impact of IAS was discussed at the ground-breaking international Convention on Biological Diversity in 1992 and, since that time, targeted legislation to prevent introduction and spread of these harmful species has been introduced at a national and European level. The most relevant legislation that takes IAS into account in Ireland is summarised in Table 1.1.

**Table 1.1:** National and European legislation concerning invasive alien species.

|                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                     |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>Republic of Ireland: European Union (Birds and Natural Habitats) Regulations 2011, S.I. 477</b><br/> <a href="http://www.irishstatutebook.ie/eli/2011/si/477/made/en/print">http://www.irishstatutebook.ie/eli/2011/si/477/made/en/print</a></p>                                                                                                            | <p>Regulation 49 on the ‘Prohibition on introduction and dispersal of certain species’ makes it an offence to knowingly disperse or allow to escape species that are listed in the Third Schedule, which is the list of high impact IAS that are subject to restrictions under the Regulations.</p> |
| <p><b>Republic of Ireland: River Basin Management Plan for Ireland 2018 – 2021 (Water Framework Directive)</b><br/> <a href="https://www.housing.gov.ie/sites/default/files/publications/files/rbmp_report_english_web_version_final_0.pdf">https://www.housing.gov.ie/sites/default/files/publications/files/rbmp_report_english_web_version_final_0.pdf</a></p> | <p>For the first time invasive species have been explicitly mentioned in this latest cycle of the River Basin Management Plan (RBMP) for Ireland. A list of Principal Actions on invasive species has been included</p>                                                                             |

|                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                                                                                                                                              | (e.g. implement the EU (European Union) IAS Regulation, develop Management Plans for IAS, develop national guidelines for biosecurity).                                                                                                                                                                                                                                                                                                                                       |
| <b>Republic of Ireland: Control of the use of pesticides and biocides</b><br><a href="https://www.nibusinessinfo.co.uk/content/pesticides-and-biocides">https://www.nibusinessinfo.co.uk/content/pesticides-and-biocides</a> | A guide to appropriate use of herbicides, pesticides, and other biocides.                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Republic of Ireland: Sustainable Use of Pesticides Directive</b><br><a href="http://www.pcs.agriculture.gov.ie/sud/">http://www.pcs.agriculture.gov.ie/sud/</a>                                                           | The Sustainable Use of Pesticides Directive (SUD) establishes a framework for European Community action to achieve the sustainable use of pesticides by setting minimum rules to reduce the risks to human health and the environment that are associated with pesticide use. It also promotes the use of integrated pest management. The Directive is designed to further enhance the high level of protection achieved through the entire regulatory system for pesticides. |
| <b>Invasive Alien Species Regulation (EU) 1143/2014</b><br><a href="http://ec.europa.eu/environment/nature/invasivealien/list/index_en.htm">http://ec.europa.eu/environment/nature/invasivealien/list/index_en.htm</a>       | This EU Regulation entered into force on 1 <sup>st</sup> January 2015. Central to the legislation is the establishment, and regular updating, of a list of IAPS considered to be of Union concern ('the Union list'). The placing of a species on the Union list activates a number of obligations on Member States (MS) regarding those species (e.g. "Within 18 months of an IAS being included on                                                                          |

|  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|--|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  | <p>the Union list, MS shall have in place effective management measures for those invasive alien species of Union concern...". The 49 species included on the Union list are subject to restrictions on keeping, importing, selling, breeding and growing. Member States are required to take action on pathways of unintentional introduction, take measures for early detection and rapid eradication of these species, and to manage species that are already widely spread in their territory.</p> |
|--|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

## 2. SURVEY RESULTS

It has been ascertained from previous surveys (2022-2025) that there are abundant infestations of Japanese knotweed and Himalayan balsam throughout the proposed development works area west of the Kilkenny Road (Plate 2.1).



**Plate 2.1:** General invasive species distribution at Mortarstown site.



### 3. SPECIES DESCRIPTION

#### 3.1. Himalayan balsam

Himalayan balsam is a non-native invasive riparian plant species that is widespread throughout Northern Ireland and the Republic of Ireland. An individual plant may produce as many as 2,500 seeds with its method of dispersal contributing towards its invasiveness. When seed pods have fully matured they explosively split open, propelling the contents up to 7 meters from the parent plant which, in large stands, can lead to densities of up to 6,000 seeds per square metre. Seeds can also float leading to dispersal throughout an infested watercourse. They also can be dispersed by wind and animals moving through the site. The plant species is frequently found as dense monocultures in riparian zones and moist woodlands or floodplains in close proximity to watercourses. Himalayan balsam becomes dominant through its rapid growth pattern with plants reaching up to 3 meters in height. It can outcompete native vegetation by shading leading to severe impacts on local biodiversity. When parent plants die back in winter, they leave riverbanks exposed and vulnerable to erosion. This can lead to siltation and the further dispersal of seeds downstream (Figures 3.1 - 4).



**Figure 3.1:** Himalayan Balsam in Flower



**Figure 2.2:** HB Stem  
(Pics courtesy CABI)



**Figure 3.3:** HB Leaf



**Figure 3.4:** HB Root

### 3.2. Japanese knotweed

|                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|--------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Distinguishing features</b> | <p>Knotweed will be described in the context of Japanese knotweed (<i>Reynoutria japonica</i>) for the purposes of this report. Japanese knotweed is a robust, vigorous herbaceous perennial that grows in dense and often continuous stands. Individual plants are up to 3m tall. Japanese knotweed has branched, hollow, red or purple mottled bamboo-like shoots. In winter the stems remain visible as tall, dry, straw-coloured, hollow canes.</p> <p>Leaves are over to 17cm long, bright green, shield- or heart-shaped but with a flattened (truncate) base and lacking any obvious hairs on the underside. Lower leaves lack the truncated base in Japanese knotweed. Leaves arranged in zig-zag pattern on an arching stem. Flowers are small, creamy-white and hang in clusters from leaf axils; the cluster is the same size as the subtending leaf.</p> <p>This species has deeply penetrating, woody rhizomes – up to 2m deep and 7m from the last visible plant.</p> |
| <b>Habitat</b>                 | <p>This is a species of waste ground, roadsides, rail corridors and riparian habitats - alongside lakes, rivers, canals, ponds and ditches in rich to poor soil types.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>Ecology</b>                 | <p>Non-native species (native to East Asia in Japan, China and Korea) and widespread in Ireland.</p> <p>Two closely related knotweed species are present in Ireland and can be equally problematic to Japanese knotweed. These are Giant knotweed (<i>R. sachalinensis</i>) and Japanese knotweed (<i>R. japonica</i>).</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Impact</b>                  | <p>This species can impact on biodiversity by outcompeting native plants. Riparian habitats invaded by knotweeds have lower invertebrate abundance, species richness and biomass, and lower plant species richness compared to uninvaded sites, which is likely to impact on local fauna that use riparian habitats.</p> <p>Following dieback in winter the ground surrounding infestations is left vulnerable to soil erosion and bankside subsidence due to the absence of a root weft that is normally produced by native grasses and herbs to bind the soils against winter floods.</p>                                                                                                                                                                                                                                                                                                                                                                                         |

|                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|--------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                    | The presence of Japanese knotweed leaf litter in streams has also been shown to have adverse effects on the species composition of affected streams.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Dispersal</b>   | The rhizomes of this species are highly regenerative and even small rhizome fragments can produce new plants. Rhizome material can remain dormant in the soil for many years. Cut or discarded stems with nodes can also root and produce new plant stands. As only female plants have been recorded in Ireland, no viable seeds are produced.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Legislation</b> | Japanese knotweed is subject to restrictions under Regulations 49 and 50 (the latter not currently commenced) of the European Communities (Birds and Natural Habitats) Regulations 2011 (SI No. 477), being listed in the Third Schedule (Part 1) of this legislative Act. Soil taken from a place that is infested with Japanese knotweed (vector material) is also restricted under Part 3 of this Third Schedule. The law relating to Japanese knotweed is primarily contained in Regulation 49 (2), which states that it is an offence to 'allow or cause to disperse' plants listed in the Third Schedule, of which Japanese knotweed is one. As such, any Japanese knotweed plant material or contaminated soil that is to be removed from an infested site can only be done so under a licence issued by the National Parks and Wildlife Service (NPWS). |
| <b>Biosecurity</b> | Do not cut or interfere with the plant. Report any sighting of additional infestations of this species immediately. Exclusion/Buffer zones for machinery and personnel will be put in place for all infestations. Do not dig or carry out ground works in or near infestations until a suitable biosecurity plan has been put in place.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Management</b>  | Mechanical (excavation or root barriers) and herbicide (foliar application or stem injection) management options can achieve effective control of all knotweed species. All management works will require a full site-specific Management Plan as well as post treatment monitoring and may require a licence from the National Parks and Wildlife Service (NPWS).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |





**Figure 3.6:** Identification of Japanese knotweed throughout the year.



**Figure 3.7:** Japanese knotweed key identification features.



## 4. MANAGEMENT PLAN

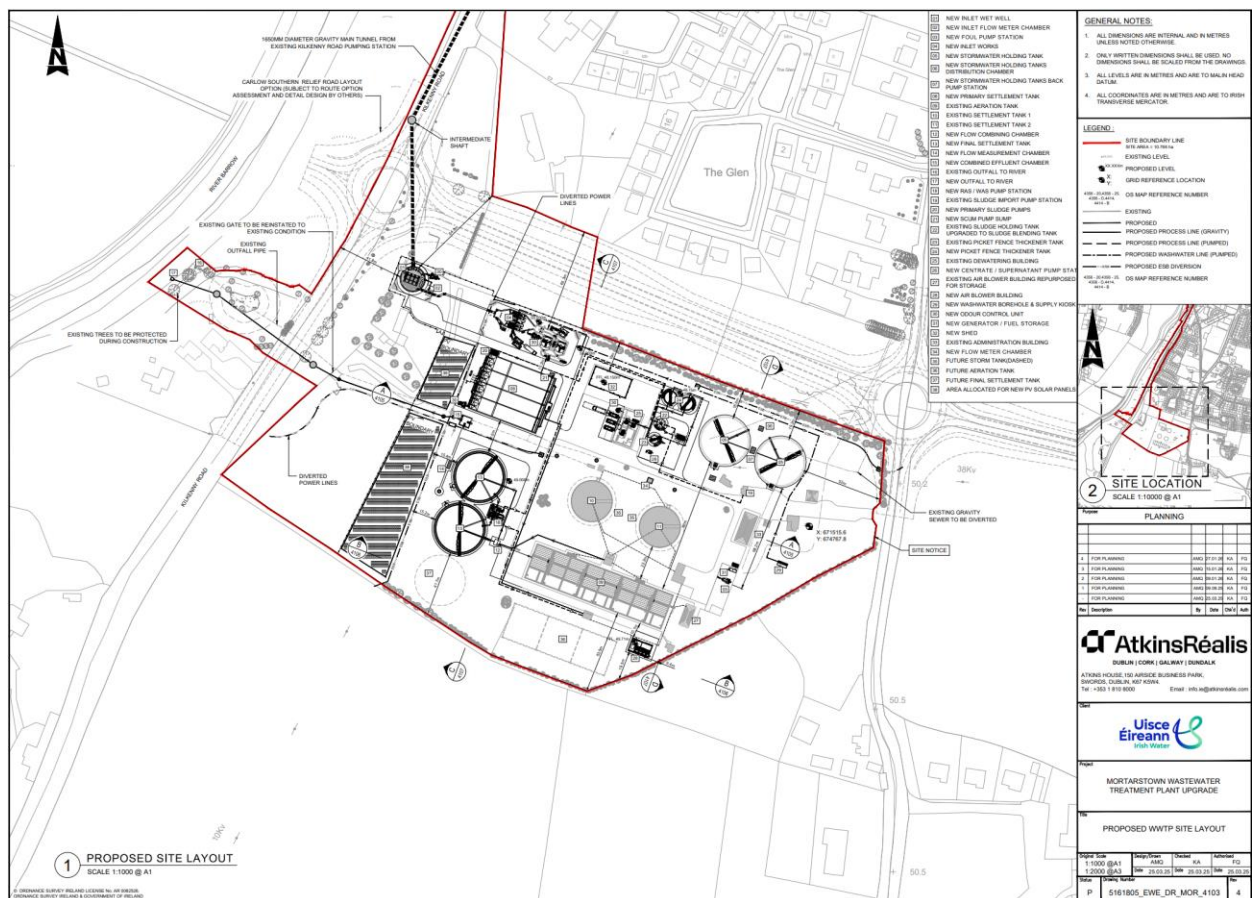
### 4.1. Excavation and disposal off-site

To facilitate the laying of the outfall pipe from its emergence from below ground to the river it is planned to excavate the area within the Japanese knotweed infested zone to a depth of 2 metres (Plates 4.1-4.2). Due to biodiversity concerns and collateral damage to trees the excavation will be limited to that necessary for the installation of the outfall pipe, with the arising material being stockpiled and removed off-site for disposal as described in this section.

This will require site operations to excavate all Japanese knotweed plants and associated contaminated soil within this area. The soil and plant material will be carefully stockpiled in preparation for removal by bio secure trucks which will transport the contaminated material to the licenced IMS landfill at Naul, Co. Dublin. Strict biosecurity protocols must be adhered to at all times during this process. Detailed records of all operations will be maintained by throughout the project. This will specifically focus on the exact areas excavated, the method of excavation, the depth of excavation, the volume of material (as numbers of truck loads) removed, an inventory of personnel and equipment entering and leaving the Japanese knotweed demarcated areas, and the operation of cleaning and disinfection facilities provided. Any problems encountered during the operation will also be recorded. The excavated area can be backfilled with inert soil from site works on the east side of the Kilkenny Road.



### Plate 4.1: Japanese knotweed infestations at Mortarstown



**Plate 4.2.** Proposed excavation area (courtesy AtkinsRéalis)

## 5. BIOSECURITY PLAN.

The successful implementation of this Biosecurity Plan will prevent the spread of Himalayan balsam and Japanese knotweed throughout the area or beyond as a result of the proposed works.

The widespread distribution of the Himalayan balsam infestations makes it certain that there is a large and extensive seed bank depository within this zone. INVAS advises that the entire area west of the Kilkenny Road be regarded as infested and would recommend that the works in this area should proceed on this understanding.

### 5.1. Pre Works

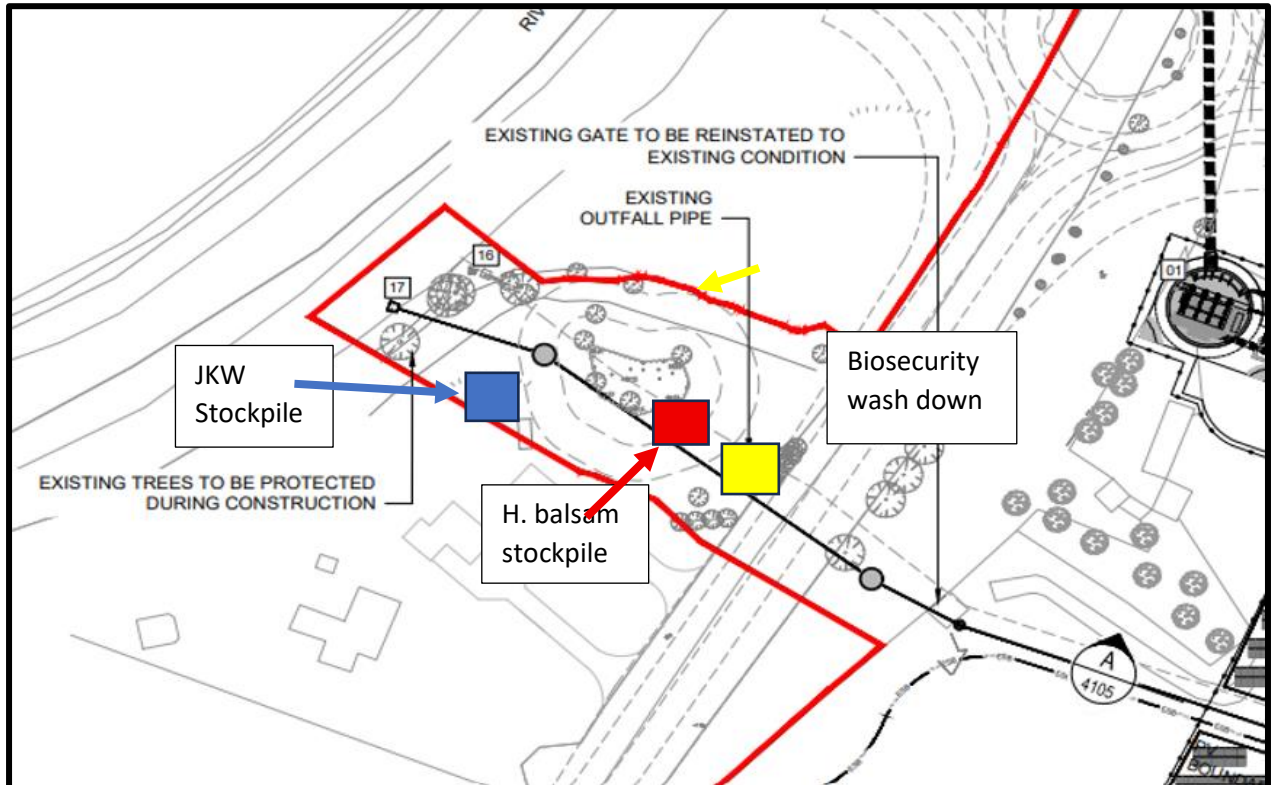
It is anticipated that the works will follow three phases i.e. surveying, ground works, construction. As there will be considerable movement of surveyors, trial holing and other visitors to the site prior to construction work commencing, it is therefore essential that these visitors are made aware of their responsibilities in preventing the spread of IAPS throughout the site and beyond. The Japanese knotweed infested areas must be fenced off, allowing for a 7metre buffer zone around each infestation. Signage should be erected throughout the site highlighting to all visitors that they are encroaching on IAPS-contaminated ground.

Suitable entrance and egress points will be identified and established both for foot and vehicular traffic and these points must be demarcated as the only possible entry or exit points available to and from the site. All equipment used in sampling or trial holing must be washed down before exiting the site. Boot wash facilities equipped with a boot scraper, hard brushes and a disinfectant solution will be positioned at the pedestrian exit. A washdown pad will be established on stone at the exit with a power washer available to wash wheels, tracks etc. A sump will be constructed adjacent to this stand to capture runoff from the wash down process. Alternatively, and preferably, a permanent drive through wheel wash can be positioned at this point which will be ideal for long term works.

### 5.2. Ground works

A haul road will be established by the placement of heavy duty matting. This will reduce the possibility of the further spread of Himalayan balsam throughout the site. If it is deemed necessary to remove soil that may contain balsam seed, this should be

stockpiled on a root barrier membrane at a suitable location adjacent to the haul road for later removal to the IMS landfill at Naul, Co. Dublin. (Plate 5.1).



**Plate 5.1:** Works footprint.

It is anticipated that the initial ground works will involve the clearance of trees and undergrowth to facilitate the establishment of haul routes and compounds. The resulting brash from these initial works will be regarded as contaminated material and be chipped and deposited in the stockpile. Tree trunks, boughs and roots must be washed down before being transported to a green waste landfill.

All soil that is removed within the JKW infested zone will be stockpiled on a root barrier membrane for later removal off site. Soil outside the above JKW zone that is considered as contaminated with Himalayan balsam seed should be stockpiled separately on a root barrier to be removed off site, as disposal costs are 50% less than that of JKW.

On completion of the works, the heavy duty matting used on the haul road will be considered as contaminated and will be washed down before removal off site. All tunnelling machinery, equipment and vehicles must be washed down of all debris before



exiting the site. A WAC (Waste Acceptance Criteria) test and a NPWS Reg 49 Licence will be required for removal of spoil to the land fill.

### 5.3. Construction

It is intended to employ tunnelling methodology to insert the outfall pipe from the Kilkenny Road. Should the tunnelling impinge on the Japanese knotweed infested areas including the surrounding 7 metre buffer zones the resulting spoil must be considered contaminated and be deposited on the stockpile. No plant or machinery can exit the site for other requirements without first being thoroughly washed down and consequently, it is recommended that these works be placed at the end of the schedule of works to minimise this process.

Once the surface of the construction site has been cleared of its potential seed bank, the risk of dispersal of the Himalayan balsam seed will have been greatly reduced. There will, however, be further ongoing risks of contamination as the site is surrounded by Himalayan balsam infestations making it vulnerable to reinfestation by wind borne seeds. There will also be river bourn seed from upriver which will be a constant source of recontamination. It will be important that biosecurity protocols continue to be observed throughout the construction period. This will require all personnel to be aware and observe basic biosecurity protocols, i.e. vehicles to pass through the wheel wash when exiting the site, including all personnel cleaning boots before leaving the site.

### 5.4. Post Works

For a minimum of 4 years following completion of construction, Uisce Eireann shall continue to monitor the invasive alien plant species on this site and implement the biosecurity measures described in the NIS including the Biosecurity SOP set out in this document. They will manage the Himalayan balsam infestation in the vicinity of the outfall, following Irish Water Guidance of the Management of Himalayan balsam (IAMT-GL-022). Any regrowth of treated infestations shall be accurately mapped and reported to Uisce Eireann.

### 5.5. Biosecurity Standard Operating Procedure for Personnel and Equipment

This plan provides standardised practical methods for cleaning and disinfecting all equipment that comes into contact with 'Third Schedule' IAPS while carrying out the works. It will enhance the existing biosecurity activity to deliver an improved biosecurity system that will help stop the spread of Himalayan balsam, Japanese knotweed.

- Before commencement of operations at the site, a toolbox talk to will be presented to all personnel that are likely to use the site.
- An access and egress route to the works area will be put in place before works commence. Only personnel and machinery that are involved in the work activities are permitted to enter this zone. A disinfectant foot bath and brushes will be provided in this area for all personnel to clean their boots before emerging from this zone.
- All machinery / tools that will be used within the works area must be thoroughly cleaned before exiting the works area.

As the works are being carried out adjacent to the river Barrow it is recommended that Virkon Aquatic disinfectant be used in all wash down and disinfection processes. All staff that are involved in the works should have access to disinfection facilities that include but is not limited to:

- Detailed guide to proper cleaning and disinfection procedure and instructions for making the correct disinfection concentration.
- A solution of clean water and Virkon Aquatic tablets or powder for the disinfection of equipment and PPE
- Hard-bristle brushes

Before commencing operations, a 1% Virkon Aquatic disinfection solution (10g Virkon Aquatic powder in 1 litre of clean water) should be prepared for staff working in infested areas. The disinfectant solution will remain pink in colour while it is still active. Additional clean water should be readily available for further disinfectant solution is required.

Best biosecurity practice will be achieved by ensuring that the following guidelines are adhered to when planning work activities.

It is important that all PPE and equipment used are cleaned and disinfected according to the procedures below. These biosecurity measures should be conducted before leaving the site.

- Put on disposable gloves before cleaning and disinfecting the equipment.
- Visually inspect all equipment for evidence of attached IAPS material, or adherent mud or debris. Remove any such material before cleaning and disinfecting the equipment and leaving the site.
- Dispose of any IAPS material taken from the equipment onto infested area.
- Use the hard-bristle brush to remove all mud and debris from boots and equipment. Then spray with the prepared disinfectant solution onto the cleaned surfaces to the point of run-off. During inspection and cleaning, pay particular attention to places where IAPS could be accidentally trapped, such as the treads of boots and attachment points on equipment.
- Remove disposable gloves and dispose of safely.

#### 5.6. Biosecurity Standard Operating Procedure for Vehicles and Plant.

All machinery that will be used on the site must be thoroughly cleaned before entering the site (to avoid contaminating the site with invasive species from elsewhere) and again sprayed with a solution of Virkon Aquatic Disinfectant and cleaned before leaving the works area. A designated route will be marked out from which vehicles will not deviate. Trucks will enter the site and be loaded directly from the stockpiles. The trucks will be loaded to a maximum level of 100cms below the top sides of truck. The load will be covered over by a tarpaulin before exiting the site. The trucks wheels and undercarriage will be inspected to ensure that they are fully bio secure and will be washed down with a solution of Virkon Aquatic before exiting the site. On completion of the works the load area of the trucks will be washed out using a solution of Virkon Aquatic disinfectant. All machinery used in the excavation process must be washed and disinfected before exiting the site. Following the removal of all contaminated material the area will be handed back to the contractor to progress with the upgrade. All personnel including drivers must disinfect their boots and any equipment used at the disposal site. Following the

completion of the excavation and disposal works an end of contract report detailing the specifics and metrics of the operations will be drawn up.









## 6. References

The following guidance documents were consulted for the preparation of this report.

- *Inland Fisheries Ireland guidance regarding aquatic invasive species control.* (<http://www.fisheriesireland.ie/Research/invasive-species.com>)
- *Japanese knotweed (Kelly et al 2008)*
- *Invasive Species Ireland guidance* (<http://invasivespeciesireland.com>)
- *Irish Water (2016) Information and Guidance Document on Japanese knotweed*
- *NPWS (2011) Actions for Biodiversity 2011-2016.*
- *EA (2006) The Knotweed Code of Practice. Managing Japanese knotweed on development sites*
- *NRA (2010) Guidelines on management of noxious weeds and non-native invasive plant species on national roads.*
- *Stokes et al. (2004) Invasive species in Ireland*
- *Dept Of Environment (2013) An Invasive Alien Species for N. Ireland*

## Appendices



## Appendix 2: Biosecurity Record for vehicles

|  Daily Biosecurity Record Sheet  |             |                                                     |         |                  |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-----------------------------------------------------|---------|------------------|
| Site ID                                                                                                                                                                                              | Mortarstown |                                                     |         |                  |
| Project details                                                                                                                                                                                      |             |                                                     |         |                  |
| Biosecurity supervisor                                                                                                                                                                               |             |                                                     |         |                  |
| Date                                                                                                                                                                                                 |             |                                                     |         |                  |
| Infestation /works boundary in place (Yes/No)                                                                                                                                                        |             | Vehicle access demarcated (Yes/No)                  |         |                  |
| Staff access/egress decontamination in place (Yes/No)                                                                                                                                                |             | Vehicle/equipment decontamination in place (Yes/No) |         |                  |
| Vehicle (description/reg)                                                                                                                                                                            | Activity    | Time decontaminated                                 | Picture | Driver signature |
|                                                                                                                                                                                                      |             |                                                     |         |                  |
|                                                                                                                                                                                                      |             |                                                     |         |                  |
|                                                                                                                                                                                                      |             |                                                     |         |                  |
|                                                                                                                                                                                                      |             |                                                     |         |                  |
|                                                                                                                                                                                                      |             |                                                     |         |                  |
|                                                                                                                                                                                                      |             |                                                     |         |                  |
| Notes/Comments:                                                                                                                                                                                      |             |                                                     |         |                  |

### Appendix 3: Schedule of activities.

|  Schedule of Activities  |                     |      |                     |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|------|---------------------|
| Site ID                                                                                                                                                                                      | Mortarstown         |      |                     |
| Project details                                                                                                                                                                              | Site investigations |      |                     |
| Biosecurity supervisor                                                                                                                                                                       |                     |      |                     |
| Date                                                                                                                                                                                         |                     |      |                     |
|                                                                                                                                                                                              | Phase               | Date | Additional comments |
| Site survey and development of Management Plan                                                                                                                                               | 1                   |      |                     |
| Establish and implement biosecurity protocol                                                                                                                                                 | 2                   |      |                     |
| Erection of fencing and signage                                                                                                                                                              | 3                   |      |                     |
| Toolbox talks to appropriate staff                                                                                                                                                           | 4                   |      |                     |
| Implementation of Management Plan                                                                                                                                                            | 5                   |      |                     |
| Decontamination of vehicles and equipment                                                                                                                                                    | 6                   |      |                     |
| Sign off                                                                                                                                                                                     | 7                   |      |                     |

• **Appendix 4: Non-native invasive plant species regulated by the European Union (Birds and Natural Habitats) Regulations 2011 to 2015**

| • Common name            | Scientific name                           | Geographical application |
|--------------------------|-------------------------------------------|--------------------------|
| American skunk-cabbage   | <i>Lysichiton americanus</i>              | Throughout the State     |
| A red alga               | <i>Grateloupia doryphora</i>              | Throughout the State     |
| Brazilian giant-rhubarb  | <i>Gunnera manicata</i>                   | Throughout the State     |
| Broad-leaved rush        | <i>Juncus planifolius</i>                 | Throughout the State     |
| Cape pondweed            | <i>Aponogeton distachyos</i>              | Throughout the State     |
| Cord-grasses             | <i>Spartina</i> (all species and hybrids) | Throughout the State     |
| Curly waterweed          | <i>Lagarosiphon major</i>                 | Throughout the State     |
| Dwarf eel-grass          | <i>Zostera japonica</i>                   | Throughout the State     |
| Fanwort                  | <i>Cabomba caroliniana</i>                | Throughout the State     |
| Floating pennywort       | <i>Hydrocotyle ranunculoides</i>          | Throughout the State     |
| Fringed water-lily       | <i>Nymphoides peltata</i>                 | Throughout the State     |
| Giant hogweed            | <i>Heracleum mantegazzianum</i>           | Throughout the State     |
| Giant knotweed           | <i>Fallopia sachalinensis</i>             | Throughout the State     |
| Giant-rhubarb            | <i>Gunnera tinctoria</i>                  | Throughout the State     |
| Giant salvinia           | <i>Salvinia molesta</i>                   | Throughout the State     |
| Himalayan balsam         | <i>Impatiens glandulifera</i>             | Throughout the State     |
| Himalayan knotweed       | <i>Persicaria wallichii</i>               | Throughout the State     |
| Hottentot-fig            | <i>Carpobrotus edulis</i>                 | Throughout the State     |
| Japanese knotweed        | <i>Fallopia japonica</i>                  | Throughout the State     |
| Large-flowered waterweed | <i>Egeria densa</i>                       | Throughout the State     |
| Mile-a-minute weed       | <i>Persicaria perfoliata</i>              | Throughout the State     |
| New Zealand pigmy weed   | <i>Crassula helmsii</i>                   | Throughout the State     |
| Parrot's feather         | <i>Myriophyllum aquaticum</i>             | Throughout the State     |
| Rhododendron             | <i>Rhododendron ponticum</i>              | Throughout the State     |

| • Common name       | Scientific name                | Geographical application |
|---------------------|--------------------------------|--------------------------|
| Salmonberry         | <i>Rubus spectabilis</i>       | Throughout the State     |
| Sea-buckthorn       | <i>Hippophae rhamnoides</i>    | Throughout the State     |
| Spanish bluebell    | <i>Hyacinthoides hispanica</i> | Throughout the State     |
| Three-cornered leek | <i>Allium triquetrum</i>       | Throughout the State     |
| Wakame              | <i>Undaria pinnatifida</i>     | Throughout the State     |
| Water chestnut      | <i>Trapa natans</i>            | Throughout the State     |
| Water fern          | <i>Azolla filiculoides</i>     | Throughout the State     |
| Water lettuce       | <i>Pistia stratiotes</i>       | Throughout the State     |
| Water-primrose      | <i>Ludwigia</i> (all species)  | Throughout the State     |
| Waterweeds          | <i>Elodea</i> (all species)    | Throughout the State     |
| Wireweed            | <i>Sargassum muticum</i>       | Throughout the State     |

### **Part 3: Vector Materials**

| Vector material                                                                                                                                                                                                                                            | Species referred to                                                                                                                                                  | Geographical application |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| Blue mussel ( <i>Mytilus edulis</i> ) seed for aquaculture taken from places (including places outside the State) where there are established populations of the slipper limpet ( <i>Crepidula fornicata</i> ) or from places within 50 km. of such places | Mussel ( <i>Mytilus edulis</i> )<br>Slipper limpet<br>( <i>Crepidula fornicata</i> )                                                                                 | Throughout the State     |
| Soil or spoil taken from places infested with Japanese knotweed ( <i>Fallopia japonica</i> ), giant knotweed ( <i>Fallopia sachalinensis</i> ) or their hybrid Bohemian knotweed ( <i>Fallopia x bohemica</i> )                                            | Japanese knotweed<br>( <i>Fallopia japonica</i> )<br><br>Giant knotweed ( <i>Fallopia sachalinensis</i> )<br><br>Bohemian knotweed<br>( <i>Fallopia x bohemica</i> ) | Throughout the State     |



## Appendix 6: Non-native Invasive Plant species of European Concern

### PLANTS

| Scientific name                                                          | English name             | Entry into force |
|--------------------------------------------------------------------------|--------------------------|------------------|
| <i>Acacia saligna</i> ( <i>Acacia cyanophylla</i> )                      | Golden wreath wattle     | 15-Aug-19        |
| <i>Ailanthus altissima</i>                                               | Tree of heaven           | 15-Aug-19        |
| <i>Alternanthera philoxeroides</i>                                       | Alligator weed           | 02-Aug-17        |
| <i>Andropogon virginicus</i>                                             | Broomsedge bluestem      | 15-Aug-19        |
| <i>Asclepias syriaca</i>                                                 | Common milkweed          | 02-Aug-17        |
| <i>Baccharis halimifolia</i>                                             | Eastern baccharis        | 03-Aug-16        |
| <i>Cabomba caroliniana</i>                                               | Fanwort                  | 03-Aug-16        |
| <i>Cardiospermum grandiflorum</i>                                        | Balloon vine             | 15-Aug-19        |
| <i>Cortaderia jubata</i>                                                 | Purple pampas grass      | 15-Aug-19        |
| <i>Eichhornia crassipes</i>                                              | Water hyacinth           | 03-Aug-16        |
| <i>Elodea nuttallii</i>                                                  | Nuttall's waterweed      | 02-Aug-17        |
| <i>Ehrharta calycina</i>                                                 | Perennial veldt grass    | 15-Aug-19        |
| <i>Gunnera tinctoria</i>                                                 | Chilean rhubarb          | 02-Aug-17        |
| <i>Gymnocoronis spilanthoides</i>                                        | Senegal tea plant        | 15-Aug-19        |
| <i>Heracleum mantegazzianum</i>                                          | Giant hogweed            | 02-Aug-17        |
| <i>Heracleum persicum</i>                                                | Persian hogweed          | 03-Aug-16        |
| <i>Heracleum sosnowskyi</i>                                              | Sosnowsky's hogweed      | 03-Aug-16        |
| <i>Humulus scandens</i>                                                  | Japanese hop             | 15-Aug-19        |
| <i>Hydrocotyle ranunculoides</i>                                         | Floating pennywort       | 03-Aug-16        |
| <i>Impatiens glandulifera</i>                                            | Himalayan balsam         | 02-Aug-17        |
| <i>Lagarosiphon major</i>                                                | Curly waterweed          | 03-Aug-16        |
| <i>Lespedeza cuneata</i> ( <i>Lespedeza juncea</i> var. <i>sericea</i> ) | Chinese bushclover       | 15-Aug-19        |
| <i>Ludwigia grandiflora</i>                                              | Water-primrose           | 03-Aug-16        |
| <i>Ludwigia peploides</i>                                                | Floating primrose-willow | 03-Aug-16        |
| <i>Lygodium japonicum</i>                                                | Vine-like fern           | 15-Aug-19        |
| <i>Lysichiton americanus</i>                                             | American skunk cabbage   | 03-Aug-16        |
| <i>Microstegium vimineum</i>                                             | Japanese stiltgrass      | 02-Aug-17        |
| <i>Myriophyllum aquaticum</i>                                            | Parrot's feather         | 03-Aug-16        |
| <i>Myriophyllum heterophyllum</i>                                        | Broadleaf watermilfoil   | 02-Aug-17        |
| <i>Parthenium hysterophorus</i>                                          | Whitetop weed            | 03-Aug-16        |
| <i>Pennisetum setaceum</i>                                               | Crimson fountaingrass    | 02-Aug-17        |
| <i>Persicaria perfoliata</i>                                             | Asiatic tearthumb        | 03-Aug-16        |
| <i>Prosopis juliflora</i>                                                | Mesquite                 | 15-Aug-19        |
| <i>Pueraria lobata</i>                                                   | Kudzu vine               | 03-Aug-16        |
| <i>Salvinia molesta</i> ( <i>Salvinia adnata</i> )                       | Salvinia moss            | 15-Aug-19        |
| <i>Triadica sebifera</i> ( <i>Sapium sebiferum</i> )                     | Chinese tallow           | 15-Aug-19        |





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Company Registration Number: 509929  
VAT Number: IE 98205960

## D.3 IAPS Control Report (INVAS, 2025)

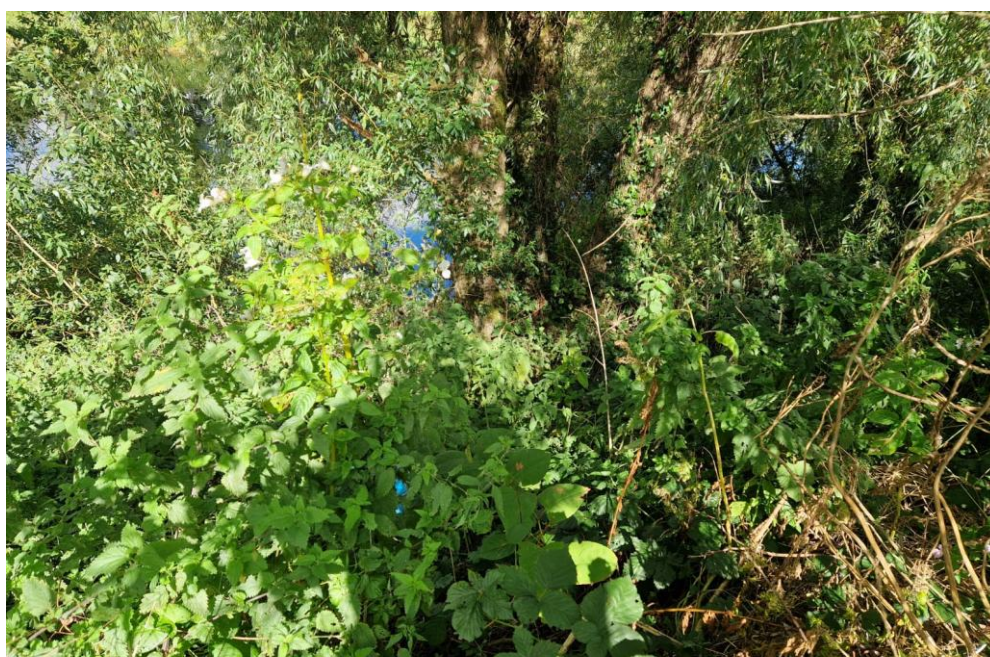






## Invasive Alien Plant Species Control Works Report

### Mortarstown, Carlow, Co. Carlow



Prepared by: INVAS Biosecurity  
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| Client         |                |            | Project                     | Approved by            |
|----------------|----------------|------------|-----------------------------|------------------------|
| AtkinsRéalisis |                |            | IAPS control at Mortarstown |                        |
| Ver.           | Date           | Details    |                             |                        |
| 1              | September 2025 | JK Control | Noel McCarthy               | Tom Donovan (Director) |

*Cover photo: Japanese knotweed and Himalayan balsam at Mortarstown.*

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**APPENDIX**

## 1. Introduction

At the request of AtkinsRéalis INVAS Biosecurity (INVAS) was commissioned to carry out a herbicide treatment to a Japanese knotweed infestation at the Mortarstown site, Carlow, Co. Carlow. Himalayan balsam was also observed onsite at the time of the treatment works.

### 1.1. Japanese Knotweed

Japanese knotweed is a non-native, highly invasive perennial plant that spreads rapidly via rhizome (i.e. underground stem) growth and fragmentation. Fragments of stem and rhizome are viable and can effectively spread and propagate this species. To date, only female plants of Japanese knotweed have been recorded in Ireland and, although the plant can produce seeds, most are believed to be sterile.

Japanese knotweed overwinters as an extensive and intricate underground rhizome matrix. The rhizome system may achieve a depth in excess of 1.8 metres and can extend laterally up to 7 metres from the visible parent plant. Rhizomes have extremely high regenerative potential and a fragment as small as 1cm in length can produce a new population. Rhizomes may remain dormant in the soil for many years. The robust and extensive woody rhizomes of Japanese knotweed are capable of penetrating asphalt, cracked foundations, walls, pipes, drainage works and other built structures, causing significant structural damage. By eliminating native vegetation on roadsides, river banks and elsewhere, the invasive plant can also cause biodiversity loss and seriously damaging subsidence. Failure to manage Japanese knotweed will result in its spread and proliferation in infested areas and beyond.

### 1.2. Legal Requirements and Implications for Management

Japanese knotweed is subject to restrictions under Regulations 49 and 50 (the latter not currently commenced) of the European Communities (Birds and Natural Habitats) Regulations 2011 (SI No. 477), being listed in the Third Schedule (Part 1) of this legislative Act. Soil taken from a place that is infested with Japanese knotweed (vector material) is also restricted under Part 3 of this Third Schedule. The law relating to Japanese knotweed is primarily contained in Regulation 49 (2), which states that it is an offence to ‘allow or cause to disperse’ plants listed in the Third Schedule, of which Japanese knotweed is one.



**Table 1.1:** National and European legislation concerning invasive alien species.

|                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Republic of Ireland: European Union (Birds and Natural Habitats) Regulations 2011, S.I. 477</b><br><a href="http://www.irishstatutebook.ie/eli/2011/si/477/made/en/print">http://www.irishstatutebook.ie/eli/2011/si/477/made/en/print</a>                                                                                                            | Regulation 49 on the ‘Prohibition on introduction and dispersal of certain species’ makes it an offence to knowingly disperse or allow to escape species that are listed in the Third Schedule, which is the list of high impact IAS that are subject to restrictions under the Regulations.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Republic of Ireland: River Basin Management Plan for Ireland 2018 – 2021 (Water Framework Directive)</b><br><a href="https://www.housing.gov.ie/sites/default/files/publications/files/rbmp_report_english_web_version_final_0.pdf">https://www.housing.gov.ie/sites/default/files/publications/files/rbmp_report_english_web_version_final_0.pdf</a> | For the first time invasive species have been explicitly mentioned in this latest cycle of the River Basin Management Plan (RBMP) for Ireland. A list of Principal Actions on invasive species has been included (e.g. implement the EU (European Union) IAS Regulation, develop Management Plans for IAS, develop national guidelines for biosecurity).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Republic of Ireland: Sustainable Use of Pesticides Directive</b><br><a href="http://www.pcs.agriculture.gov.ie/sud/">http://www.pcs.agriculture.gov.ie/sud/</a>                                                                                                                                                                                       | The Sustainable Use of Pesticides Directive (SUD) establishes a framework for European Community action to achieve the sustainable use of pesticides by setting minimum rules to reduce the risks to human health and the environment that are associated with pesticide use. It promotes the use of integrated pest management. The Directive is designed to enhance the high level of protection achieved through the entire regulatory system for pesticides.                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Invasive Alien Species Regulation (EU) 1143/2014</b><br><a href="http://ec.europa.eu/environment/nature/invasivealien/list/index_en.htm">http://ec.europa.eu/environment/nature/invasivealien/list/index_en.htm</a>                                                                                                                                   | This EU Regulation entered into force on 1 <sup>st</sup> January, 2015. Central to the legislation is the establishment, and regular updating, of a list of IAPS considered to be of Union concern (‘the Union list’). The placing of a species on the Union list activates a number of obligations on Member States (MS) regarding those species (e.g. “Within 18 months of an IAS being included on the Union list, MS shall have in place effective management measures for those invasive alien species of Union concern...”). The 49 species included on the Union list are subject to restrictions on keeping, importing, selling, breeding and growing. Member States are required to take action on pathways of unintentional introduction, take measures for early detection and rapid eradication of these species, and to manage species that are already widely spread in their territory. |

## 2. Works

### 2.1. Herbicide Treatment 2025

The site is infested with mature Japanese knotweed plants on the left bank of the Barrow river and smaller stands in the wooded area of the adjacent private property. The stems in the larger stand exceeded a diameter of 10mm and reached a height of 1,500 mm.



**Plate 1:** Juvenile Japanese knotweed growth.



**Plate 2:** Japanese knotweed growth on adjacent private property.



**Plate 3:** Map of Japanese knotweed infestations at Mortarstown.

INVAS Biosecurity carried out a herbicide treatment on 26th September 2025, Herbicide application was carried out to the manufacturer's guidelines and by staff wearing suitable PPE and in possession of the relevant qualifications. Records of herbicide use were kept in accordance with relevant legislation and are retained after each treatment.

The Japanese knotweed at the Mortarstown site has been treated with a foliar application of a glyphosate-based herbicide (Roundup® Biactive). Spraying was carried out at a rate of 5L/Ha using a knapsack fitted with low pressure drift beta nozzles. An inert dye (super signal blue) was mixed with the solution to ensure all plants at the site are treated. Chemical application was focused on the upper and lower leaves of Japanese knotweed to minimise the risk of drift to neighbouring plants or watercourse.



**Table 2.1:** Treatment details for the Japanese knotweed

|                            |                                 |
|----------------------------|---------------------------------|
| <b>Site ID</b>             | JKO_Mortarstown                 |
| <b>Treatment Company</b>   | INVAS Biosecurity Ltd.          |
| <b>Treated By</b>          | Noel McCarthy                   |
| <b>Treatment Date/Time</b> | 26 <sup>th</sup> September 2025 |
| <b>Treatment method</b>    | Foliar application              |
| <b>Herbicide used</b>      | Glyphosate                      |
| <b>PSCS number</b>         | PU 025465                       |
| <b>Calibration rate/Ha</b> | 5L/H                            |
| <b>Total product used</b>  | Foliar application – 20ml       |
| <b>Total water used</b>    | Foliar application – 1 litre    |

### 3. Biosecurity

For the purposes of this document, biosecurity refers to all practical measures used to manage and prevent the introduction and spread of IAPS. A number of high impact aquatic and riparian IAPS are currently present in Ireland and most are continuing to spread aggressively. Prominent among the terrestrial IAPS are: Japanese knotweed (*Fallopia japonica*), Giant knotweed (*Fallopia sachalinensis*), Bohemian knotweed (*Fallopia x bohemica*), Giant hogweed (*Heracleum mantegazzianum*) and Himalayan balsam (*Impatiens glandulifera*). All of the above are listed in the Third Schedule (Parts 1 and 2) of the Habitats Directive (S.I. 477/2011) and some are included among the list of 49 EU IAS UnionConcern([http://ec.europa.eu/environment/nature/pdf/IAS\\_brochure\\_species.pdf](http://ec.europa.eu/environment/nature/pdf/IAS_brochure_species.pdf)) in the EU Invasive Alien Species Regulations (1143/2014).

The ecological effects of IAS are often irreversible and, once established, they are extremely difficult and costly to control and eradicate; hence, the urgent need to prevent their introduction and spread. Prevention is clearly more cost-effective and less environmentally damaging than long-term containment, control or eradication. The most effective measure to



reduce introductions and halt spread of IAS is to promote and implement good biosecurity practice

INVAS Biosecurity staff used Virkon™ Aquatic for the disinfection of all necessary PPE and equipment prior to arrival and departure from this site. Strict biosecurity was observed during the operation at all times during works at this site. Rhizome fragments pose a great threat in the spread of knotweed species. Disinfection kits were provided to all staff entering or exiting areas of infestation to prevent the inadvertent spread of propagules. All staff and entering and exiting the treatment area were required to use suitable disinfection facilities. No unauthorized staff were permitted to enter the site during the treatment process.

## 4. REFERENCES

The following guidance documents were consulted for the preparation of this report.

- Inland Fisheries Ireland guidance regarding aquatic invasive species control. (<http://www.fisheriesireland.ie/Research/invasive-species.com>)
- Kelly, J., Tosh, D., Dale, K., and Jackson, A., 2013. The economic cost of invasive and non-native species in Ireland and Northern Ireland. A report prepared for the Northern Ireland Environment Agency and National Parks and Wildlife Service as part of Invasive Species Ireland.
- Irish Water (2016) Information and Guidance Document on Japanese knotweed
- NPWS (2011) Actions for Biodiversity 2011-2016.
- Department of Housing, Local Government and Heritage - River Basin Management Plan 2018 – 2021.
- Department of Housing, Local Government and Heritage - River Basin Management Plan 2022 – 2027.
- EA (2006) The Knotweed Code of Practice. Managing Japanese knotweed on development sites
- NRA (2010) Guidelines on management of noxious weeds and non-native invasive plant species on national roads.
- Stokes et al. (2004) Invasive species in Ireland
- Dept Of Environment (2013) An Invasive Alien Species Strategy for Northern Ireland



## Appendices

|  <div style="text-align: center;">Schedule of Activities</div>  |                           |           |                          |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|-----------|--------------------------|
| Site ID                                                                                                                                                                                                                             | JKO_Mortarstown           |           |                          |
| Project details                                                                                                                                                                                                                     | Japanese knotweed Control |           |                          |
| Contact                                                                                                                                                                                                                             |                           |           |                          |
| Telephone                                                                                                                                                                                                                           |                           |           |                          |
| Operator                                                                                                                                                                                                                            | Date                      | Weather   | Product /Rate/Vol        |
| N.McCarthy                                                                                                                                                                                                                          | 26/09/2025                | Excellent | Glyphosate / 5L/h / 20ml |
|                                                                                                                                                                                                                                     |                           |           |                          |
|                                                                                                                                                                                                                                     |                           |           |                          |
|                                                                                                                                                                                                                                     |                           |           |                          |
|                                                                                                                                                                                                                                     |                           |           |                          |
|                                                                                                                                                                                                                                     |                           |           |                          |
|                                                                                                                                                                                                                                     |                           |           |                          |
|                                                                                                                                                                                                                                     |                           |           |                          |
|                                                                                                                                                                                                                                     |                           |           |                          |
|                                                                                                                                                                                                                                     |                           |           |                          |



**Appendix 2:** Non-native invasive plant species regulated by the European Union (Birds and Natural Habitats) Regulations 2011 to 2015.

| Common name              | Scientific name                           | Geographical application |
|--------------------------|-------------------------------------------|--------------------------|
| American skunk-cabbage   | <i>Lysichiton americanus</i>              | Throughout the State     |
| A red alga               | <i>Grateloupia doryphora</i>              | Throughout the State     |
| Bohemian knotweed        | <i>Fallopia x bohémica</i>                | Throughout the State     |
| Brazilian giant-rhubarb  | <i>Gunnera manicata</i>                   | Throughout the State     |
| Broad-leaved rush        | <i>Juncus planifolius</i>                 | Throughout the State     |
| Cape pondweed            | <i>Aponogeton distachyos</i>              | Throughout the State     |
| Cord-grasses             | <i>Spartina</i> (all species and hybrids) | Throughout the State     |
| Curly waterweed          | <i>Lagarosiphon major</i>                 | Throughout the State     |
| Dwarf eel-grass          | <i>Zostera japonica</i>                   | Throughout the State     |
| Fanwort                  | <i>Cabomba caroliniana</i>                | Throughout the State     |
| Floating pennywort       | <i>Hydrocotyle ranunculoides</i>          | Throughout the State     |
| Fringed water-lily       | <i>Nymphoides peltata</i>                 | Throughout the State     |
| Giant hogweed            | <i>Heracleum mantegazzianum</i>           | Throughout the State     |
| Giant knotweed           | <i>Fallopia sachalinensis</i>             | Throughout the State     |
| Giant-rhubarb            | <i>Gunnera tinctoria</i>                  | Throughout the State     |
| Giant salvinia           | <i>Salvinia molesta</i>                   | Throughout the State     |
| Himalayan balsam         | <i>Impatiens glandulifera</i>             | Throughout the State     |
| Himalayan knotweed       | <i>Persicaria wallichii</i>               | Throughout the State     |
| Hottentot-fig            | <i>Carpobrotus edulis</i>                 | Throughout the State     |
| Japanese knotweed        | <i>Fallopia japonica</i>                  | Throughout the State     |
| Large-flowered waterweed | <i>Egeria densa</i>                       | Throughout the State     |
| Mile-a-minute weed       | <i>Persicaria perfoliata</i>              | Throughout the State     |
| New Zealand pigmy weed   | <i>Crassula helmsii</i>                   | Throughout the State     |

| Common name         | Scientific name                | Geographical application |
|---------------------|--------------------------------|--------------------------|
| Parrot's feather    | <i>Myriophyllum aquaticum</i>  | Throughout the State     |
| Rhododendron        | <i>Rhododendron ponticum</i>   | Throughout the State     |
| Salmonberry         | <i>Rubus spectabilis</i>       | Throughout the State     |
| Sea-buckthorn       | <i>Hippophae rhamnoides</i>    | Throughout the State     |
| Spanish bluebell    | <i>Hyacinthoides hispanica</i> | Throughout the State     |
| Three-cornered leek | <i>Allium triquetrum</i>       | Throughout the State     |
| Wakame              | <i>Undaria pinnatifida</i>     | Throughout the State     |
| Water chestnut      | <i>Trapa natans</i>            | Throughout the State     |
| Water fern          | <i>Azolla filiculoides</i>     | Throughout the State     |
| Water lettuce       | <i>Pistia stratiotes</i>       | Throughout the State     |
| Water-primrose      | <i>Ludwigia</i> (all species)  | Throughout the State     |
| Waterweeds          | <i>Elodea</i> (all species)    | Throughout the State     |
| Wireweed            | <i>Sargassum muticum</i>       | Throughout the State     |

### **Part 3: Vector Materials**

| Vector material                                                                                                                                                                                                                                            | Species referred to                                                                                                                                                  | Geographical application |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| Blue mussel ( <i>Mytilus edulis</i> ) seed for aquaculture taken from places (including places outside the State) where there are established populations of the slipper limpet ( <i>Crepidula fornicata</i> ) or from places within 50 km. of such places | Mussel ( <i>Mytilus edulis</i> )<br>Slipper limpet<br>( <i>Crepidula fornicata</i> )                                                                                 | Throughout the State     |
| Soil or spoil taken from places infested with Japanese knotweed ( <i>Fallopia japonica</i> ), giant knotweed ( <i>Fallopia sachalinensis</i> ) or their hybrid Bohemian knotweed ( <i>Fallopia x bohemica</i> )                                            | Japanese knotweed<br>( <i>Fallopia japonica</i> )<br><br>Giant knotweed ( <i>Fallopia sachalinensis</i> )<br><br>Bohemian knotweed<br>( <i>Fallopia x bohemica</i> ) | Throughout the State     |

### Appendix 3 Non-native Invasive Plant species of European Concern

#### PLANTS

| Scientific name                                                          | English name             | Entry into force |
|--------------------------------------------------------------------------|--------------------------|------------------|
| <i>Acacia saligna</i> ( <i>Acacia cyanophylla</i> )                      | Golden wreath wattle     | 15-Aug-19        |
| <i>Ailanthus altissima</i>                                               | Tree of heaven           | 15-Aug-19        |
| <i>Alternanthera philoxeroides</i>                                       | Alligator weed           | 02-Aug-17        |
| <i>Andropogon virginicus</i>                                             | Broomsedge bluestem      | 15-Aug-19        |
| <i>Asclepias syriaca</i>                                                 | Common milkweed          | 02-Aug-17        |
| <i>Baccharis halimifolia</i>                                             | Eastern baccharis        | 03-Aug-16        |
| <i>Cabomba caroliniana</i>                                               | Fanwort                  | 03-Aug-16        |
| <i>Cardiospermum grandiflorum</i>                                        | Balloon vine             | 15-Aug-19        |
| <i>Cortaderia jubata</i>                                                 | Purple pampas grass      | 15-Aug-19        |
| <i>Eichhornia crassipes</i>                                              | Water hyacinth           | 03-Aug-16        |
| <i>Elodea nuttallii</i>                                                  | Nuttall's waterweed      | 02-Aug-17        |
| <i>Ehrharta calycina</i>                                                 | Perennial veldt grass    | 15-Aug-19        |
| <i>Gunnera tinctoria</i>                                                 | Chilean rhubarb          | 02-Aug-17        |
| <i>Gymnocoronis spilanthoides</i>                                        | Senegal tea plant        | 15-Aug-19        |
| <i>Heracleum mantegazzianum</i>                                          | Giant hogweed            | 02-Aug-17        |
| <i>Heracleum persicum</i>                                                | Persian hogweed          | 03-Aug-16        |
| <i>Heracleum sosnowskyi</i>                                              | Sosnowsky's hogweed      | 03-Aug-16        |
| <i>Humulus scandens</i>                                                  | Japanese hop             | 15-Aug-19        |
| <i>Hydrocotyle ranunculoides</i>                                         | Floating pennywort       | 03-Aug-16        |
| <i>Impatiens glandulifera</i>                                            | Himalayan balsam         | 02-Aug-17        |
| <i>Lagarosiphon major</i>                                                | Curly waterweed          | 03-Aug-16        |
| <i>Lespedeza cuneata</i> ( <i>Lespedeza juncea</i> var. <i>sericea</i> ) | Chinese bushclover       | 15-Aug-19        |
| <i>Ludwigia grandiflora</i>                                              | Water-primrose           | 03-Aug-16        |
| <i>Ludwigia peploides</i>                                                | Floating primrose-willow | 03-Aug-16        |
| <i>Lygodium japonicum</i>                                                | Vine-like fern           | 15-Aug-19        |
| <i>Lysichiton americanus</i>                                             | American skunk cabbage   | 03-Aug-16        |
| <i>Microstegium vimineum</i>                                             | Japanese stiltgrass      | 02-Aug-17        |
| <i>Myriophyllum aquaticum</i>                                            | Parrot's feather         | 03-Aug-16        |
| <i>Myriophyllum heterophyllum</i>                                        | Broadleaf watermilfoil   | 02-Aug-17        |
| <i>Parthenium hysterophorus</i>                                          | Whitetop weed            | 03-Aug-16        |
| <i>Pennisetum setaceum</i>                                               | Crimson fountaingrass    | 02-Aug-17        |
| <i>Persicaria perfoliata</i>                                             | Asiatic tearthumb        | 03-Aug-16        |
| <i>Prosopis juliflora</i>                                                | Mesquite                 | 15-Aug-19        |
| <i>Pueraria lobata</i>                                                   | Kudzu vine               | 03-Aug-16        |
| <i>Salvinia molesta</i> ( <i>Salvinia adnata</i> )                       | Salvinia moss            | 15-Aug-19        |
| <i>Triadica sebifera</i> ( <i>Sapium sebiferum</i> )                     | Chinese tallow           | 15-Aug-19        |

## ANIMALS

| Scientific name                                 | English name                                        | Entry into force |
|-------------------------------------------------|-----------------------------------------------------|------------------|
| <i>Acridotheres tristis</i>                     | Common myna                                         | 15-Aug-19        |
| <i>Alopochen aegyptiacus</i>                    | Egyptian goose                                      | 02-Aug-17        |
| <i>Arthurdendylus triangulatus</i>              | New Zealand flatworm                                | 15-Aug-19        |
| <i>Callosciurus erythraeus</i>                  | Pallas' squirrel                                    | 03-Aug-16        |
| <i>Corvus splendens</i>                         | Indian house crow                                   | 03-Aug-16        |
| <i>Eriocheir sinensis</i>                       | Chinese mitten crab                                 | 03-Aug-16        |
| <i>Herpestes javanicus</i>                      | Small Asian mongoose                                | 03-Aug-16        |
| <i>Lepomis gibbosus</i>                         | Pumpkinseed                                         | 15-Aug-19        |
| <i>Lithobates catesbeianus</i>                  | American bullfrog                                   | 03-Aug-16        |
| <i>Muntiacus reevesi</i>                        | Muntjac deer                                        | 03-Aug-16        |
| <i>Myocastor coypus</i>                         | Coypu                                               | 03-Aug-16        |
| <i>Nasua nasua</i>                              | Coati                                               | 03-Aug-16        |
| <i>Nyctereutes procyonoides</i>                 | Raccoon dog                                         | 02-Feb-19        |
| <i>Ondatra zibethicus</i>                       | Muskrat                                             | 02-Aug-17        |
| <i>Orconectes limosus</i>                       | Spiny-cheek crayfish                                | 03-Aug-16        |
| <i>Orconectes virilis</i>                       | Virile crayfish                                     | 03-Aug-16        |
| <i>Oxyura jamaicensis</i>                       | Ruddy duck                                          | 03-Aug-16        |
| <i>Pacifastacus leniusculus</i>                 | Signal crayfish                                     | 03-Aug-16        |
| <i>Percottus glenii</i>                         | Amur sleeper                                        | 03-Aug-16        |
| <i>Plotosus lineatus</i>                        | Striped eel catfish                                 | 15-Aug-19        |
| <i>Procambarus clarkii</i>                      | Red swamp crayfish                                  | 03-Aug-16        |
| <i>Procambarus fallax</i> f. <i>virginialis</i> | Marbled crayfish                                    | 03-Aug-16        |
| <i>Procyon lotor</i>                            | Raccoon                                             | 03-Aug-16        |
| <i>Pseudorasbora parva</i>                      | Stone moroko                                        | 03-Aug-16        |
| <i>Sciurus carolinensis</i>                     | Grey squirrel                                       | 03-Aug-16        |
| <i>Sciurus niger</i>                            | Fox squirrel                                        | 03-Aug-16        |
| <i>Tamias sibiricus</i>                         | Siberian chipmunk                                   | 03-Aug-16        |
| <i>Threskiornis aethiopicus</i>                 | Sacred ibis                                         | 03-Aug-16        |
| <i>Trachemys scripta</i>                        | Red-eared, yellow-bellied and<br>Cumberland sliders | 03-Aug-16        |
| <i>Vespa velutina nigrithorax</i>               | Asian hornet                                        |                  |





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# Appendix E. Wastewater Assimilative Capacity Assessment Report





# CIP 5 - MORTARSTOWN WWTP

# Notice

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## Client signoff

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# 1.1 Tiered Assessment Framework

An assessment of the impacts of the discharge from Mortarstown WWTP can be made using the Tiered Assessment Approach, as set out by the European Commission<sup>1</sup> and as adopted by Uisce Éireann's own Technical Guidance. The guidelines set out an approach to assessing the impact of discharges, using risk-based methods, where the level of complexity of the assessment is commensurate with the level of risk posed by a discharge.

The UÉ tiered approach for watercourses consists of five Tiers:

- Tier 0: check to see if the effluent is likely to contain a contaminant of concern. If so, check to see if the contaminant is present at levels above the Environmental Quality Standard (EQS), i.e. the maximum permitted concentration in the receiving waterbody.
- Tier 1: Check to see if discharging the contaminant(s) of concern at levels above the EQS are likely to have a significant impact on the receiving waterbody given existing ambient concentrations.
- Tier 2: An initial assessment of water quality impacts and required ELVs is made based on a simple mass balance approach (Tier 2a). If this is found to give unrealistic results, or if the resulting ELVs cannot be achieved in a cost-effective and proportionate manner, the water quality impact is further simulated using a Monte Carlo analysis (Tier 2b).
- Tier 3: If the Tier 2 assessment methods indicate that achievable ELVs cannot be applied to the discharge, or sensitive receptors are likely to be impacted upon, the mixing zone is further assessed based on achievable levels of wastewater treatment and using complex models to establish the extent of the mixing zone and duration and frequency of impacts.
- Tier 4: If the Tier 3 analysis suggests that the impacts will be significant, an investigative study is undertaken to examine the concentrations of the contaminant(s) reaching receptors, the characteristics of the receptors, their vulnerability and the ecotoxicity of the contaminants.

At each stage of the Tiered Assessment, the discharge assessment is either completed (if environmental impacts are appropriate and acceptable) or referred for additional assessment at the next stage. In the case of Mortarstown WWTP, the level of required analysis did not progress beyond a Tier 2 assessment.

The two methods of Tier 2 calculation are described below.

## 1.1.1 Simple Mass Balance Method

Simple mass balance calculations can be carried out for any given set of river quality, river flow, effluent quality and effluent flow conditions. For the purposes of assessing impacts of wastewater discharges against targets in legislation (see Section 2) two sets of calculations are typically required, the first to assess against environmental compliance with 95%ile EQS targets (carried out using low Q95 river flows) and a second calculation to assess environmental compliance against mean EQS targets (carried out using mean river flows). The calculation is shown in Equation 1.

$$C_{downstream} = \frac{Q_{eff}C_{eff} + Q_{river}C_{river}}{Q_{eff} + Q_{river}}$$

**Equation 1-1 - Mass Balance Equation**

---

<sup>1</sup> Technical Guidelines for the Identification of Mixing Zones, pursuant to Art. 4(4) of the Directive 2008/105/EC, European Commission, Brussels, 22 December 2010, C(2010) 9369



Where:  $Q_{\text{eff}}$  is the average effluent flow rate ( $\text{m}^3/\text{s}$ ) and  $C_{\text{eff}}$  is the effluent pollutant concentration ( $\text{mg/l}$ )

$Q_{\text{river}}$  is the flow in the watercourse upstream ( $\text{m}^3/\text{s}$ ) and  $C_{\text{river}}$  is the average ambient river pollutant concentration upstream of the outfall ( $\text{mg/l}$ )

$C_{\text{downstream}}$  is the resultant downstream water quality for each pollutant in the watercourse ( $\text{mg/l}$ )

The simple mass balance approach assumes that 95%ile concentrations in the river occur downstream of a discharge at the same time as  $Q_{95}$  river flows due to lack of dilution capacity within the watercourse at times of low flow. This approach also assumes that mean concentrations in the river occur downstream of a discharge at the same time as mean river flows. Because of this method of schematising river quality conditions, simple mass-balance may be considered a conservative approach compared to other methods of modelling which are capable of considering a much wider combination of flow and quality conditions in rivers and effluent.

## 1.1.2 Monte Carlo Analysis Method

If the ELVs determined on the basis of the simple mass balance (Tier 2a) approach are found to be unrealistic or give rise to ELVs that cannot be achieved in a cost-effective and proportionate manner, then the water quality impact can be simulated in greater detail using a Monte Carlo analysis (Tier 2b).

Whilst the simple mass-balance calculations are easy to apply, they do not consider the full range of river and effluent flow conditions or the range of potential quality conditions which may occur in a watercourse upstream or downstream of a discharge. The simple mass balance approach is also not able to easily take account of correlations between inputs, such as correlations between river and effluent flow rates or between effluent flow rate and effluent pollutant concentrations. These factors can be overcome using a Monte Carlo approach whereby complex statistical problems are represented using multiple different combinations of potential scenarios selected randomly from across the probability curves of both datasets. In this context, Monte Carlo analysis uses multiple combinations of watercourse and effluent flows and concentrations in order to assess the impact of the discharge over the full range of potential watercourse flow and quality conditions. This gives a more complete analysis of the impacts of a discharge on the watercourse quality and can also be adapted to account for correlations in datasets, however it does require more input data compared to a simple mass-balance approach.

Uisce Éireann have developed methods to facilitate both simple mass balance (UÉ-AMT-FM-007) and Monte Carlo analysis (UÉ-AMT-FM-008) when assessing the impacts of a WWTP discharge on receiving water quality. A simple mass balance approach has been applied to assess the impacts of the Mortarstown WWTP discharges on water quality in the River Barrow and calculate the ELVs required to deliver the appropriate level of protection to downstream water quality.

## 1.2 Report Structure

The report sets out the results of a Tiered Assessment of the Mortarstown WWTP discharge and calculation of ELVs based on simple mass balance Tier 2a assessment method. The Tier 2a calculation method relies on suitable analysis of the available environmental data and information on WWTP effluent flows and quality. The report is structured as follows:

- Section 2 provides a brief overview of legislative framework and list of substances for assessment in the tiered analysis.
- Section 3 sets out the hydrological context of the receiving waters and calculates river flow percentiles.
- Section 4 reviews the available water quality data for the receiving watercourses, checks for correlation between river flow and quality and establishes target downstream concentration values and status.



- Section 5 outlines the available effluent flow and quality data and checks for correlation between river flow and effluent flow rates and between effluent flow rate and quality.
- Section 6 provides the results of analysis at Tiers 0, 1 and 2 (simple mass balance approach).
- The report is summarised in Section 7.



## 2. Legislative Framework

### 2.1 Legislation

#### 2.1.1 Urban Wastewater Treatment Directive Regulations

The Urban Wastewater Treatment Directive Regulations 2001<sup>2</sup> (amended in 2004 and 2010) sets standards to be met in the collection and treatment of wastewater as well as the monitoring requirements for wastewater discharges from urban areas. The Environmental Protection Agency issues licences for WWTP discharges to environmental waters in accordance with the requirements of the UWWTD and the discharge licence for Mortarstown WWTP was most recently granted under this legislative instrument in August 2009 (ref. D0028-01), with technical amendments in October 2011, December 2016 and December 2021. The current ELVs applied to effluent from Mortarstown WWTP are set out in Table 2-1 and compared with effluent quality standards required for a wastewater treatment plant of its current capacity under the UWWTD.

**Table 2-1 - Current Environmental Limit Values at Mortarstown WwTP**

| Parameter                             | UWWTD Maximum Permitted Value | Current Mortarstown WWTP ELV (WWDA Regs) |
|---------------------------------------|-------------------------------|------------------------------------------|
| Chemical Oxygen Demand (COD) (mg/l)   | 125                           | 125                                      |
| Biological Oxygen Demand (BOD) (mg/l) | 25                            | 15                                       |
| Suspended Solids (mg/l)               | 35                            | 35                                       |
| pH                                    | --                            | 6.0 to 9.0                               |
| Ammonia (mg/l)                        | --                            | 2.0                                      |
| Orthophosphate (mg/l)                 | --                            | 0.80                                     |
| Total Phosphorus (mg/l)               | 1.00                          | 1.00                                     |

Under the UWWTD, secondary treatment is required for settlements with a PE of 2,000 to 10,000 and with discharges to freshwaters. Tertiary treatment is required for WWTP which serve more than 10,000 PE and which discharge to nutrient sensitive waters. The UWWTD allows for designation of environmental waters as “nutrient sensitive” and additional application of ELVs for total nitrogen and total phosphorus where this designation is applied. It is noted that the River Barrow, “*downstream of Portarlinton sewage outfall, to Graiguenamanagh Bridge*” which incorporates the Mortarstown WWTP discharge point is designated as nutrient sensitive and a total phosphorus ELV has been applied by the current discharge licence in recognition of this.

<sup>2</sup> Statutory Instruments SI No 254/2001 <https://www.irishstatutebook.ie/eli/2001/si/254/made/en/print> , accessed 12 March 2024





## 2.1.2 Surface Waters Regulations

The Water Framework Directive (WFD, Directive 2000/60/EC) defines the ecological status of waterbodies as high, good, moderate, poor or bad. Under WFD, member states are required to prevent pollution of waterbodies and work to improve water quality to a minimum of good status, provided this can be done in a cost effective and proportionate manner. The WFD was enacted into Irish Law through the European Communities Environmental Objectives (Surface Waters) Regulations 2009<sup>3</sup> (amended in 2015 and 2019 and referred to throughout this report as “the Surface Water Regulations”).

The Surface Water Regulations set standards which can be used to identify the current status of waterbodies and to determine the impacts of the discharge at Mortarstown WWTP on future water quality. The standards are set for ecological community assemblage and for physio-chemical parameters that affect it. Table 2-2 shows the standards for good and high ecological status in rivers. The discharges may directly impact on concentrations of ammonia, BOD, orthophosphate and pH and this will subsequently have impacts on river ecosystems and dissolved oxygen concentrations. This report will consider only direct impacts on river chemistry and will calculate the appropriate ELVs required to ensure protection of river ecosystems and avoid impacts on dissolved oxygen.

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<sup>3</sup> Statutory Instruments SI No 77/2019 <http://www.irishstatutebook.ie/eli/2019/si/77/made/en/print>, accessed 26 September 2024



**Table 2-2 - Water Quality Standards for River Waters under the Surface Water Regulations**

| Parameter                                            | Classification System                       | High-Good boundary                              | Good-Moderate boundary |
|------------------------------------------------------|---------------------------------------------|-------------------------------------------------|------------------------|
| Macro Invertebrates                                  | Quality Rating System (Q Value)             | 0.85                                            | 0.75                   |
| Fish                                                 | Fish Classification Scheme 2 Ireland (FCS2) | 0.845                                           | 0.540                  |
| Phytobenthos                                         | Revised form of Trophic Diatom Index (TDI)  | 0.93                                            | 0.78                   |
| Macrophytes                                          | Free Macrophyte Index                       | 0.90                                            | 0.68                   |
| Ammonia (mg/l)                                       | Mean                                        | 0.04                                            | 0.065                  |
|                                                      | 95%ile                                      | 0.09                                            | 0.14                   |
| BOD (mg/l)                                           | Mean                                        | 1.3                                             | 1.5                    |
|                                                      | 95%ile                                      | 2.2                                             | 2.6                    |
| Molybdate Reactive Phosphorus (orthophosphate, mg/l) | Mean                                        | 0.025                                           | 0.035                  |
|                                                      | 95%ile                                      | 0.045                                           | 0.075                  |
| pH                                                   | Mean                                        | Hard Water (CaCO <sub>3</sub> >100mg/l) = 6-9   |                        |
|                                                      |                                             | Soft Water (CaCO <sub>3</sub> <100mg/l) = 4.5-9 |                        |
| Dissolved Oxygen (%)                                 | 95%ile value                                | 80-120%                                         |                        |

### 2.1.3 Wastewater Discharge (Authorisation) Regulations

The Environmental Protection Agency issues licences for WWTP discharges under the Wastewater Discharge (Authorisation) Regulations (2007)<sup>4</sup> (amended in 2010 and 2024), referred to in Table 1 as the WWDA Regulations. These regulations take account of the above directives to ensure that the discharge of wastewater does not have adverse impacts on the environment. This is achieved by taking a “combined approach,” whereby *“the emission limits for the discharge are established on the basis of the stricter of either or both, the limits and controls required under the Urban Waste Water Regulations, and the limits determined under statute or Directive for the purpose of achieving the environmental objectives established for surface waters.”*

<sup>4</sup> <http://www.irishstatutebook.ie/eli/2007/si/684/made/en/print>, accessed 19 June 2020



## 2.1.4 Other Regulations

Additional protection for water quality in rivers can be applied in Ireland under the following legislative instruments:

- The EU Bathing Waters Directive (2006/7/EC, February 2006), transposed into Irish Law as the Bathing Water Quality Regulations<sup>5</sup> in 2008 with minor amendments in 2011 and 2016.
- The Shellfish Waters Directive (“Directive 2006/113/EC on the Quality Required of Shellfish Waters”) which sets out standards which must be achieved when harvesting shellfish for human consumption and is now incorporated within the Water Framework Directive.
- The 1988 Salmonid Regulations<sup>6</sup> which have been partly superseded by the Water Framework Directive.
- Habitats Directive (Directive 92/43/EEC): Treated effluent from the Mortarstown WWTP discharges and will continue to discharge to the River Barrow and River Nore Special Area of Conservation (SAC). In order to inform and assist the competent authority in making its Appropriate Assessment (AA) of the proposed Mortarstown WWTP upgrade development under Article 6(3) of the Habitats Directive, a Natura Impact Statement (NIS) will be prepared and submitted to the competent authority. The NIS will assess the implications of the WWTP upgrade project for the integrity of the SAC. As part of this, the outputs of this WAC Report will provide a basis for the assessment of the effects of the future effluent discharge on the aquatic qualifying interests of the SAC, in view of their conservation objectives.

The Barrow River is not designated as a bathing water, shellfish water or for the protection of salmon, therefore the Habitats Directive, of the above related legislative instruments apply when assessing the impacts of the Mortarstown WWTP discharge.

## 2.2 WFD Waterbodies

Mortarstown WWTP discharges to the Barrow River which is designated under the Surface Waters Directive as river waterbody Barrow\_160 (IE\_SE\_14B012460) and the existing discharge location will be utilised by the upgraded WWTP. The Barrow Catchment includes the area drained by the River Barrow upstream of the River Nore confluence and all streams entering tidal water between the Barrow railway bridge at Great Island and Ringwood, Co. Kilkenny, draining a total area of 3,025km<sup>2</sup>. The largest urban centre in the catchment is Carlow. The other main urban centres in this catchment are New Ross, Graiguenamanagh, Athy, Portlaoise, Mountmellick, Portarlinton, Monasterevin and Kildare. The Barrow main channel rises in the Slieve Bloom mountains and flows through agricultural areas, the towns of Portarlinton, Athy, and Carlow.

The New Bridge Monitoring Station (RS14B012200 upstream of the WWTP Discharge Point) identifies the waterbody as having a Moderate Q Value Status with a Q Value Score of 3-4 in 2023. The Q Value score at this Monitoring Station (RS14B012200) in 2018, 2020 and 2023 has not changed. An examination of the Monitoring Station Data indicates that an upstream Good Q Value Status is monitored at a Monitoring Station upstream of Athy (RS14B011300). Monitoring Stations (RS14B012455, RS14B012600, RS14B012680) downstream of the Mortarstown WWTP Discharge Point ) identifies the waterbody as having a Moderate Q Value Status with a Q Value Score of 3-4 in 2018, 2020 and 2023.

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<sup>5</sup> Statutory Instrument 79/2008, <https://www.irishstatutebook.ie/eli/2008/si/79/made/en/print>, accessed 12 March 2024

<sup>6</sup> <http://www.irishstatutebook.ie/eli/1988/si/293/made/en/print>, accessed 12 March 2021



The available water chemistry data for the River Barrow upstream and downstream of the Mortarstown WWTP Discharge Point is reviewed in Section 4.

## 2.3 Sensitive Receptors

Treated effluent from the Mortarstown WWTP discharges and will continue to discharge to the River Barrow and River Nore Special Area of Conservation (SAC). As noted in Section 2.1.4, the River Barrow is not designated for protection of bathing waters, shellfish or salmon and improvements to wastewater treatment are not required at this location for the protection of freshwater pearl mussel. There are no Uisce Éireann Drinking Water Abstraction Points identified downstream of the primary discharge. The watercourse is, however, designated as nutrient sensitive. The additional protection required under the UWWTD for nutrient sensitive waters is reflected in the application of the total phosphorus ELV and this is applied irrespective of receiving water quality. The substances of concern for a Teir 0 analysis in Section 6 are therefore limited to ammonia, BOD, orthophosphate and pH based on EQS for rivers as set out in the Water Framework Directive.

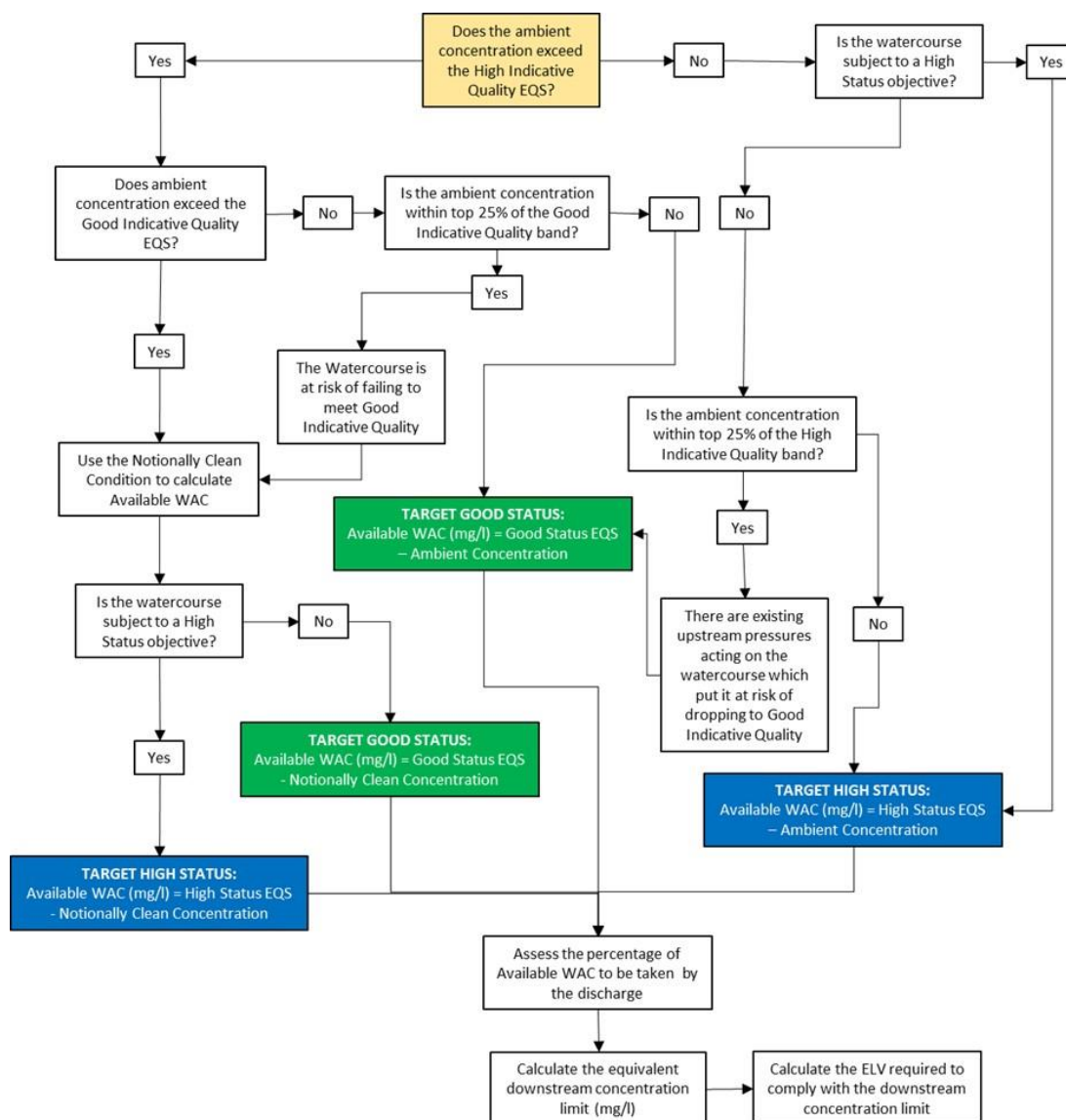
## 2.4 Assessment Methodology

Uisce Éireann have developed a methodology to ensure a consistent approach is taken to water quality impact analysis and the setting of ELVs for WWTP effluent (Interim Technical Guidance for Water Impact Assessments (Freshwater) Document No. AMT-GL-028). This approach seeks to determine an appropriate downstream target status and percentage of available wastewater assimilative capacity which can be taken by a single wastewater discharge. The available assimilative capacity is defined as the difference between the upstream river nutrient concentration and the target EQS.

Figure 2-1 provides a flow chart for identifying the target status for a watercourse as either “Good” or “High” status, and if a notionally clean approach should be applied. The flow chart is applied for both mean and 95%ile water quality, with the final target applied for each nutrient based on the worst-case upstream water quality evaluation outcome.







**Figure 2-1 - Target Status Flow Chart**

The calculation of available assimilative capacity in watercourses is predicated on the assumption that the ambient water quality is less than the EQS for each pollutant. This may not be the case in all circumstances as often a waterbody may have other upstream pressures impacting on water quality. In such circumstances a “Notionally Clean” approach is required to determine appropriate ELVs which are proportionate to the impacts of a wastewater discharge on the environment. The impact of the upstream pressures is “removed” to allow for calculation of ELVs which would deliver compliance with the target status under the Surface Water Regulations if the upstream pressures on water quality were addressed. This is simulated by applying water quality statistics at the upstream location which are equal to 20% of the high status EQS value. These approaches are required to allow for sustainable future operation of wastewater infrastructure in line with the “polluter-pays” principle in the WFD.

The outcome of this process for Mortarstown WWTP, based on the upstream river quality data discussed in Section 4 below, is that A “Notionally Clean” approach was adopted in the calculation of the ammonia and BOD ELV as the ambient river data exceeds the Good Indicative Quality EQS for BOD and ammonia.



For a given WWTP, ELVs are set such that effluent discharges utilise an appropriate percentage of the available WAC based on the sensitivity of the receiving environment. Table 2-3 provides an environmental sensitivity scoring system, which determines this sensitivity based on the characteristics of the receiving environment. The environmental sensitivity score calculated for the Barrow River at Mortarstown WWTP Discharge Point is 15.

**Table 2-3 - Environmental Sensitivity Scoring**

| Factor                               | Assessment                                                                          | Score | River Barrow at Mortarstown WWTP Discharge Point |
|--------------------------------------|-------------------------------------------------------------------------------------|-------|--------------------------------------------------|
| Current watercourse status           | Watercourse not at significant risk of WFD classification change                    | 0     |                                                  |
|                                      | Watercourse "at risk" of WFD classification change / currently failing to meet Good | 5     | 5                                                |
| <b>Discharge Location Score</b>      |                                                                                     |       |                                                  |
| Downstream Dilution                  | Q <sub>95</sub> Flow increases by <20% at next confluence (within WFD Waterbody)    | 0     | 0                                                |
|                                      | Q <sub>95</sub> flow increases by 20-50% at next confluence (within WFD Waterbody)  | -2    |                                                  |
|                                      | Q <sub>95</sub> flow increases by >50% at next confluence (within WFD Waterbody)    | -2    |                                                  |
|                                      | Q <sub>95</sub> flow increases by >80% at next confluence (within WFD Waterbody)    | -4    |                                                  |
| <b>Environmental Receptors Score</b> |                                                                                     |       |                                                  |
| Environmental Receptors              | Discharge to SPA                                                                    | 5     |                                                  |
|                                      | Discharge to Special Area of Conservation                                           | 5     | 5                                                |
|                                      | Discharge to Bathing Water                                                          | 5     |                                                  |
|                                      | Discharge to Drinking Water                                                         | 3     |                                                  |
|                                      | Discharge to Salmonid River                                                         | 4     |                                                  |
|                                      | Discharge to Shellfish Water                                                        | 2     |                                                  |
|                                      | Discharge to Nutrient Sensitive Water                                               | 5     | 5                                                |
|                                      | Discharge within 1km of SPA                                                         | 2.5   |                                                  |
|                                      | Discharge within 1km of SAC                                                         | 3     |                                                  |



| Factor | Assessment                                                                       | Score | River Barrow at Mortarstown WWTP Discharge Point |
|--------|----------------------------------------------------------------------------------|-------|--------------------------------------------------|
|        | Discharge to High Status Objective Waterbody under WFD or the Habitats Directive | 10    |                                                  |
|        | Discharge within 1km of Bathing Water                                            | 2.5   |                                                  |
|        | Discharge within 1km of Drinking Water                                           | 1.5   |                                                  |
|        | Discharge within 1km of Salmonid River                                           | 3     |                                                  |
|        | Discharge within 1km of Nutrient Sensitive Water                                 | 3     |                                                  |
|        | Discharge within 1km of Shellfish Water                                          | 1     |                                                  |
|        |                                                                                  |       | <b>TOTAL 15</b>                                  |

Table 2-4 provides the upper limits of the available WAC to be used by a WWTP discharge depending on the environmental sensitivity score and the upstream water quality. Based on the scores calculated above, Mortarstown WWTP should use 30% (at most) of the available WAC. Note the available WAC for BOD to be based on the notionally clean condition.

**Table 2-4 - Determination of Available WAC Take-Up**

| Risk Score | Amount of Available WAC to be Taken (Using Ambient Data) | Amount of WAC to be Taken (Using Notionally Clean) |
|------------|----------------------------------------------------------|----------------------------------------------------|
| up to 4    | Up to 75%                                                | Up to 50%                                          |
| 4 to 9     | Up to 50%                                                | Up to 40%                                          |
| 10 to 19   | Up to 30%                                                | Up to 30%                                          |
| 19 to 30   | Up to 25%                                                | Up to 20%                                          |
| >30        | Up to 10%                                                | Up to 10%                                          |



## 3. Hydrological Analysis

A detailed hydrological analysis has been undertaken in accordance with Uisce Eireann's Technical Guidance for Hydrological Estimation (UE-AMT-GL-022) in order to determine the prevailing river flow characteristics at the Mortarstown WWTP discharge location.

### 3.1 River Barrow Catchment and Flow Gauges

The Barrow River catchment at Mortarstown WWTP discharge point occupies an area of 2,255.7km<sup>2</sup> (Figure 3-1). The Barrow New Bridge Station (Stn. No. 14022) is located 3 km upstream of the Mortarstown WWTP discharge point, where the catchment area is 2,069.5km<sup>2</sup>. The difference in catchment area between the gauge station and the discharge point is 8.2% (Figure 3-2). As the difference in catchment areas at the gauge station and the discharge site is less than 10%, therefore the flow duration curve at the gauge station can be applied to the WWTP discharge site with simple scaling to account for the difference in catchment area.

The gauged river flow record at the Barrow New Bridge Station is used to calculate river flow statistics at Mortarstown WWTP discharge point. The Q<sub>95</sub> river flow data for the downstream Pushoge River was identified at 0.039m<sup>3</sup>/s (ref EPA Maps) indicating that the increase in Q<sub>95</sub> river flow occurring downstream of the River Barrow/Pushoge River confluence is less than 20% with a 0 score therefore being used as an input to the Environmental Sensitivity Score in Section 2.4.

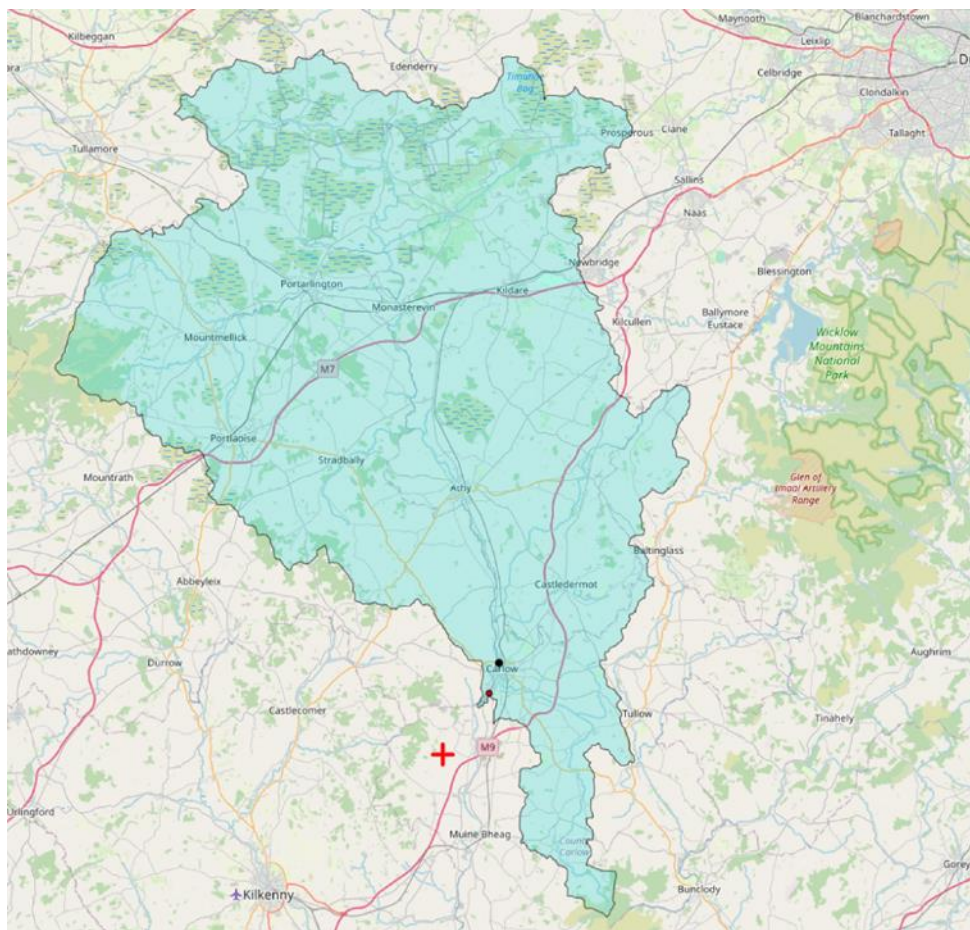
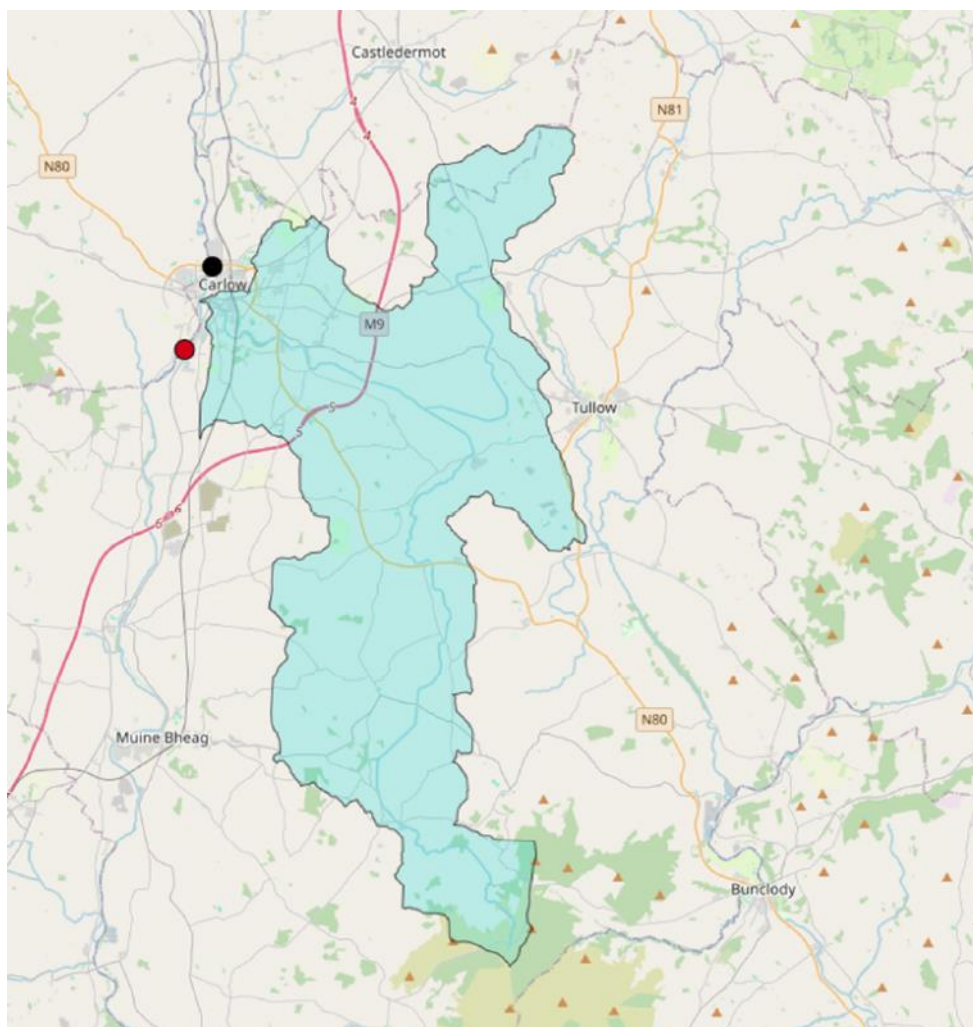


Figure 3-1 - Mortarstown WWTP Discharge Point Contributing Catchment Area





**Figure 3-2 - Catchment Area not contributing to Barrow New Bridge Station**

## 3.2 Gauged Flow Data Evaluation

Details of the gauged flow data at the Barrow New Bridge Station are provided in Table 3-1 and the annual flow data and calculated flow percentiles at the gauge station is set out in Appendix A.

**Table 3-1 - Gauging Station Details**

|                      |                        |
|----------------------|------------------------|
| Station Number       | 14022                  |
| Station Name         | Barrow New Bridge      |
| Waterbody            | River Barrow           |
| Site Owner           | Office of Public Works |
| Grid Reference       | 272025, 177741         |
| River Basin District | South Eastern          |

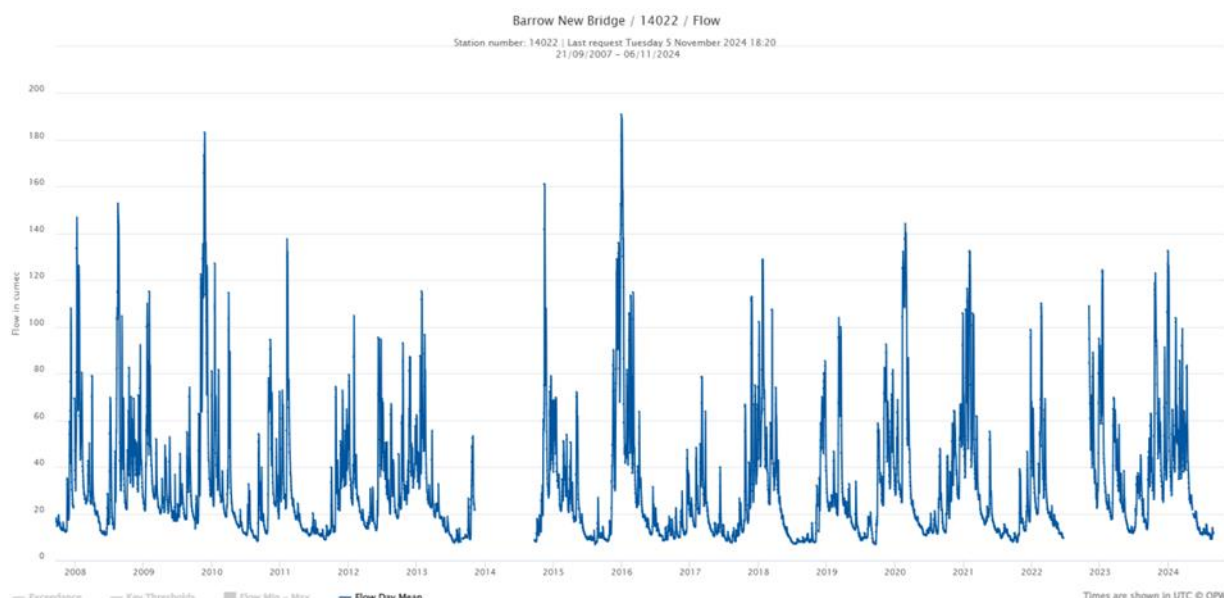


|                                   |            |
|-----------------------------------|------------|
| Catchment Area (km <sup>2</sup> ) | 2,065.5    |
| Data Start Date                   | 21/09/2007 |
| Data End Date                     | 05/11/2024 |
| Daily Data Percent Complete       | 91.2       |

The Barrow New Bridge daily flow data timeseries is shown in Figure 3-3 (OPW, 2024) and the gauge data have been reviewed for quality, non-stationarity and the impact of missing data.

The review shows that the majority of the river daily flow data timeseries as being complete with no gaps sufficient to skew the flow duration curve. The review shows that the majority of the river daily flow data timeseries is classified by the OPW as being of an acceptable or fair quality (OPW quality codes 31,36). An ADF test for stationarity indicates that flow data timeseries as having a non-stationarity characteristic in the form of reducing low annual flows, however this non-stationarity is not sufficiently apparent to justify exclusion of older data when calculating whole-record river flow statistics. Anthropogenic (or human based) influences on gauged river flow data at Barrow New Station are not considered to be significant. The upstream Srowland water treatment plant at Athy for example operates at 20 ML/d or 0.23m<sup>3</sup>/s which is not considered to be sufficiently significant relative to the River Barrow flow to skew the Barrow New Station flow duration curve.

One the basis of these checks, the daily mean flow data from the entire gauge record from the Barrow New Station can be used to produce a flow duration curve and calculate key flow percentiles for the River Barrow at the gauge. Flows at the gauge can be scaled to represent flows in the River at Mortarstown WWTP to account for the increase in catchment area between the gauge and the WWTP discharge point.

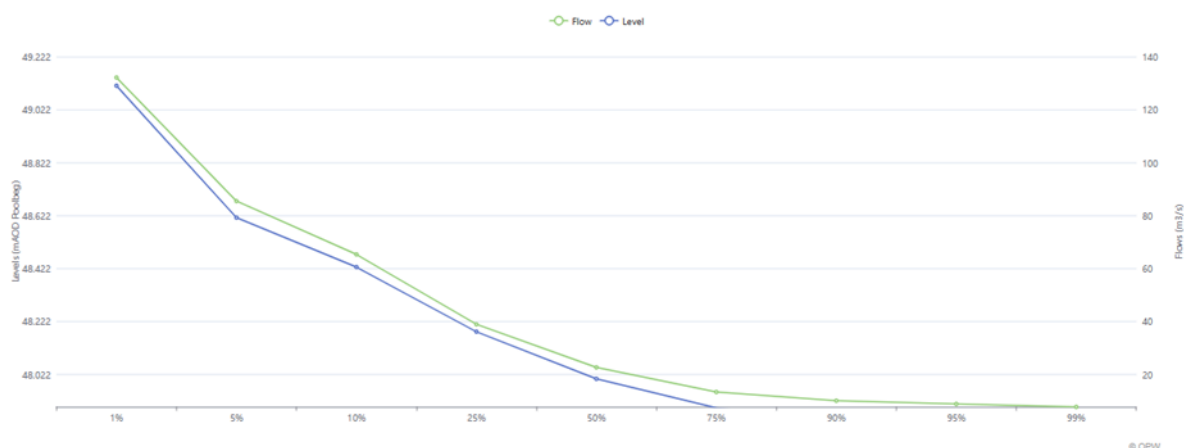


**Figure 3-3 - OPW River Flow Timeseries for River Barrow at Barrow New Bridge (Daily Mean Flows from 2008 to 2024)**



### 3.3 Gauged Flow Statistics

Figure 3-4 (OPW, 2024) shows the flow duration curve for the River Barrow at the Barrow New Bridge Station for period 2007 to 2024. River flow statistics have been calculated for the River Barrow at Mortarstown WWTP discharge point by increasing the gauged flows at Barrow New Bridge Station by 8.2% to account for the increase in catchment area between this gauge and the WWTP. Table 6 gives the scaled river flow statistics for the River Barrow at Mortarstown WWTP discharge point.



**Figure 3-4 - OPW Daily Mean Flow Duration Curves for the River Barrow at Barrow New Bridge Station**

**Table 3-2 - Flow Duration Curve Statistics for the River Barrow at Guage Station & Mortarstown WWTP Discharge Point**

| Flow Exceedance Probability (%) | New Bridge Barrow OPW Gauge Station Flow (m³/s) | Mortarstown WWTP Discharge Point Flow (m³/s) |
|---------------------------------|-------------------------------------------------|----------------------------------------------|
| 1                               | 132.118                                         | 142.952                                      |
| 5                               | 85.439                                          | 92.445                                       |
| 10                              | 65.289                                          | 70.643                                       |
| 25                              | 38.877                                          | 42.065                                       |
| 50                              | 22.589                                          | 24.441                                       |
| 75                              | 13.312                                          | 14.404                                       |
| 90                              | 10.03                                           | 10.852                                       |
| 95                              | 8.792                                           | 9.513                                        |
| 99                              | 7.69                                            | 8.321                                        |



## 4. River Water Quality Analysis

### 4.1 Monitoring Locations

River water quality is monitored on the River Barrow at locations upstream and downstream of Mortarstown WWTP discharge point. The upstream monitoring point is RS14B012310 (u/s Mortarstown WWTP), located at Graiguecullen Bridge, ≈1.8km upstream of the primary outfall. The downstream monitoring point is RS14B012460 (d/s Mortarstown WWTP) located at Dolmen Mews, ≈1.0km downstream of the primary outfall. Details of the sampling monitoring point locations are shown in Table 7.

**Table 4-1 - Water Quality Sampling Point Details**

| Upstream Sampling Point |                      |     |     | Downstream Sampling Point |     |     |
|-------------------------|----------------------|-----|-----|---------------------------|-----|-----|
| Station ID              | RS14B012310          |     |     | RS14B012460               |     |     |
| Station Name            | u/s Mortarstown WWTP |     |     | d/s Mortarstown WWTP      |     |     |
| Irish Grid Reference    | 271637, 176643       |     |     | 270576, 174121            |     |     |
| Substance               | Ammonia              | BOD | PO4 | Ammonia                   | BOD | PO4 |
| Number of Samples       | 43                   | 43  | 43  | 42                        | 43  | 43  |
| Date of First Sample    | 08/01/2020           |     |     |                           |     |     |
| Date of Last Sample     | 14/02/2024           |     |     |                           |     |     |

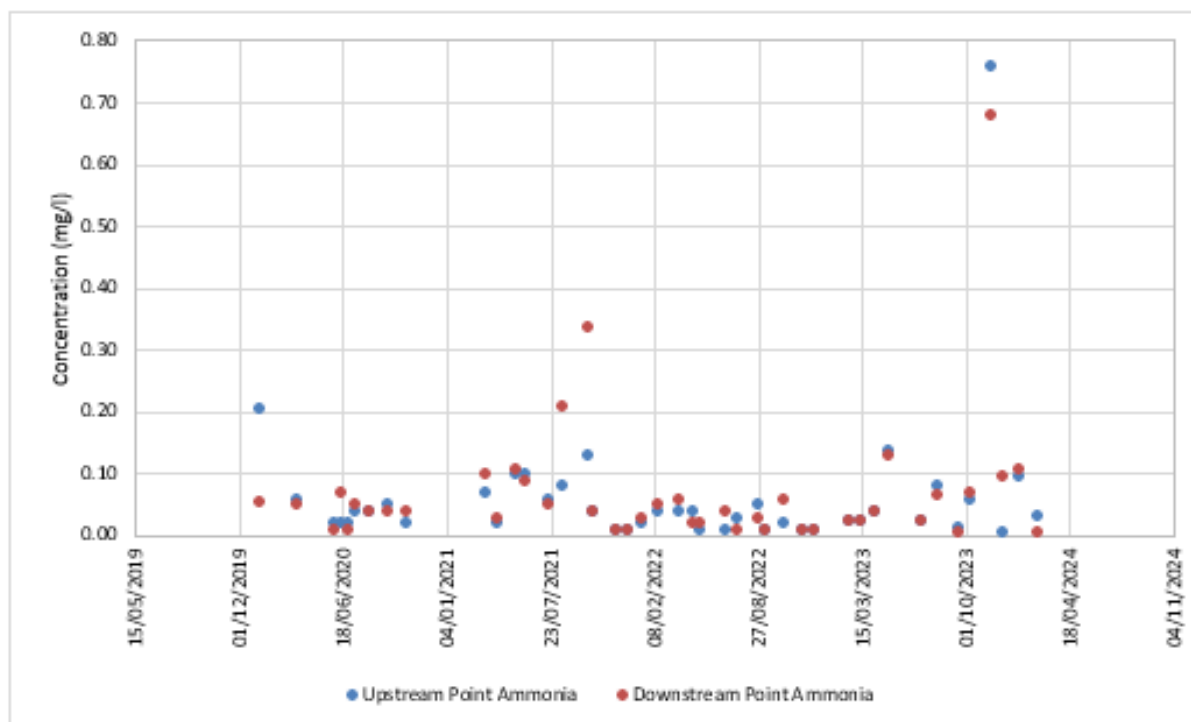
### 4.2 River Quality Timeseries

The timeseries of ammonia sampling data at the two sampling points is shown in Figure 4-1. In general, the data shows a consistent ambient concentration of ammonia, with the downstream concentrations being usually slightly higher. Two high concentration values were observed in 2023. There are no obvious trends in the river quality data which would make data from a specific period of time unrepresentative of current conditions, so the entire period of record is suitable for the calculation of water quality statistics in the River Barrow.

Comparing the ammonia concentration at the upstream monitoring point RS14B012310 with the mean river flow recorded at the New Barrow Bridge gauge shows a weak correlation between upstream river flow and the u/s ambient Ammonia quality ( $R^2 = 0.117$ ).



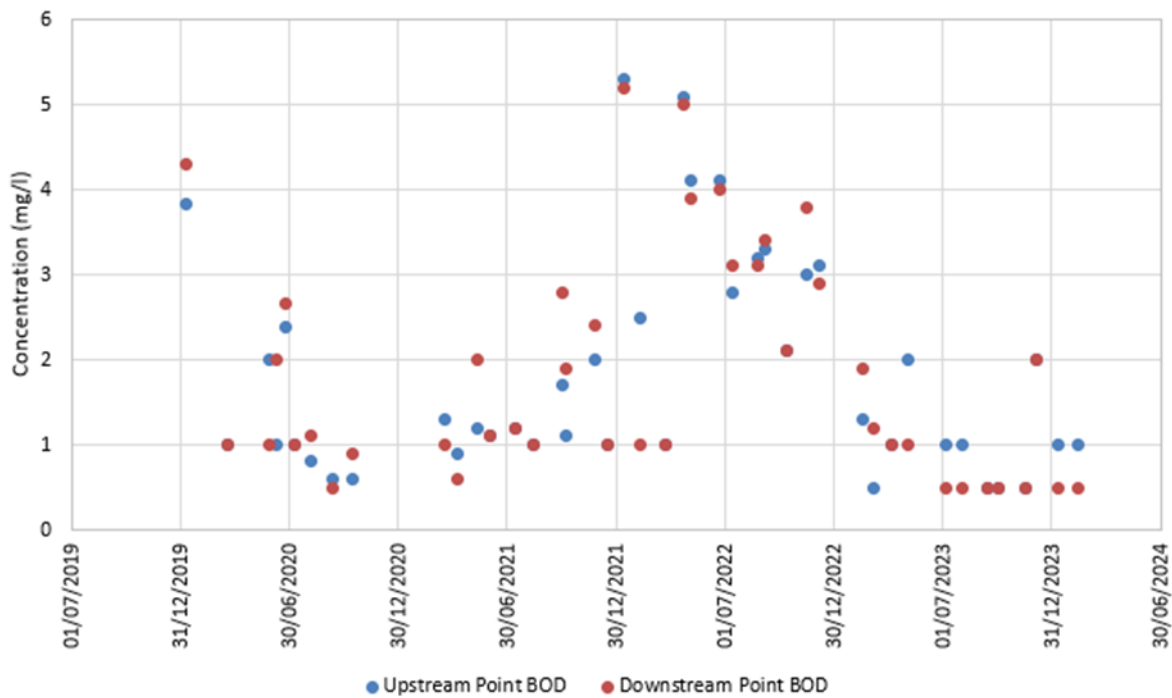




**Figure 4-1 - Ammonia Monitoring Data for the River Barrow at Mortarstown WWTP**

The timeseries of BOD sampling data at the two monitoring points is shown in Figure 4-2. There is generally limited difference in BOD concentration between the two sampling points, with upstream concentrations either slightly higher or slightly lower than at the downstream location. It is noted that the data shows elevated levels of BOD in 2022 for both upstream and downstream locations, which make the 2022 period less representative of current conditions. In line with typical water quality statistical analyses, values at or below LOD levels have been replaced with proxy values of 50% of the LOD when calculating statistical metrics. The limit of detection is higher than the mean EQS for BOD in rivers so mean BOD concentrations may be overestimated at Mortarstown relative to the EQS. This is not expected to impact significantly on the 95%ile river concentration.

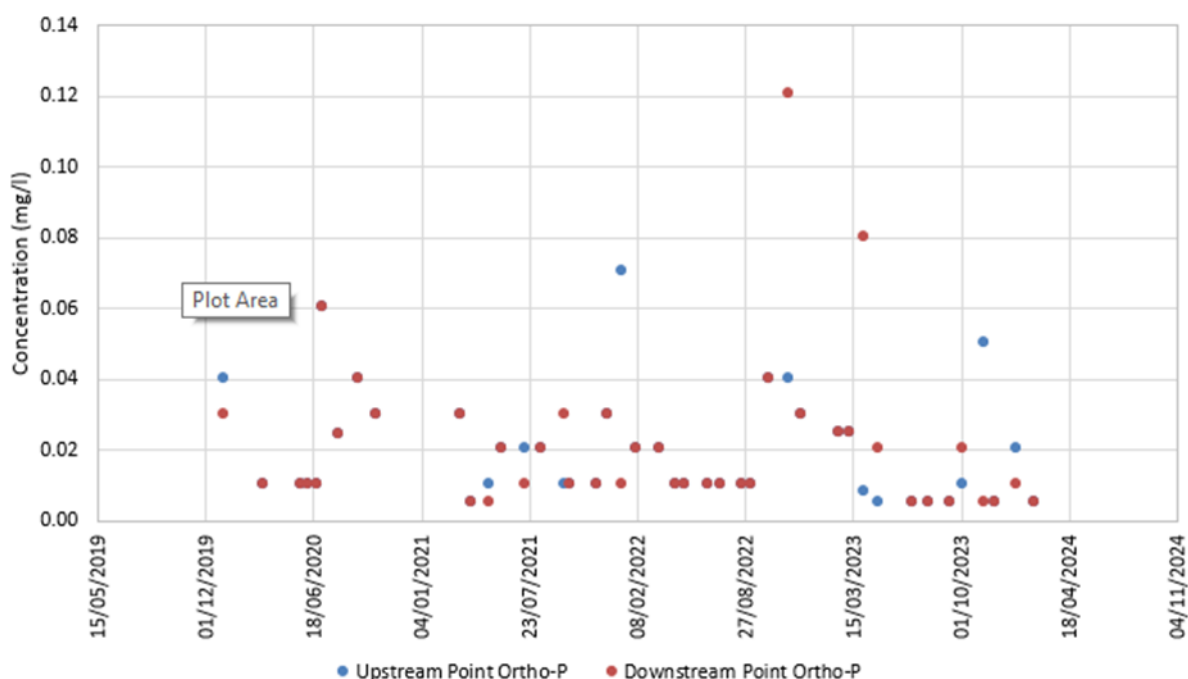
Comparing the BOD concentration at the upstream monitoring point RS14B012310 with the mean river flow recorded at the New Barrow Bridge gauge shows a weak correlation between upstream river flow and the u/s ambient BOD quality ( $R^2 = 0.021$ ).



**Figure 4-2 - BOD Monitoring Data for the River Barrow at Mortarstown WWTP**

The timeseries of orthophosphate sampling data at the two sampling points is shown in Figure 4-3. In general, the data shows a consistent ambient concentration of orthophosphate with little difference between upstream or downstream concentrations. Two higher downstream concentration values were observed in period 2023. There are no obvious trends in the river quality data which would make data from a specific period of time unrepresentative of current conditions, so the entire period of record is suitable for the calculation of water quality statistics in the River Barrow. Comparing the river orthophosphate concentration at the upstream monitoring point RS14B012310 with the mean river flow recorded at the New Barrow Bridge gauge shows a weak correlation between upstream river flow and the u/s ambient river orthophosphate quality ( $R^2 = 0.122$ ).





**Figure 4-3 - Orthophosphate Monitoring Data for the River Barrow at Mortarstown WWTP**

## 4.3 Ambient Water Quality Data

Table 4-2 sets out the overall water quality statistics for the River Barrow upstream and downstream of Mortarstown WWTP discharge point. Statistics are provided for mean and 95%ile quality for comparison with EQS under the Surface Water Regulations. Values which comply with requirements for high indicative quality are highlighted in blue, values which comply with requirements for good indicative quality are highlighted in green and values which exceed the good status EQS are highlighted in orange.

The difference in water quality statistic values between the upstream and downstream monitoring points at Mortarstown WWTP is generally small.

The EQS for good status for ammonia is on the limit at the upstream location and is exceeded for both the mean and 95%ile condition at the downstream location.

The EQS for good status for BOD is exceeded for both the mean and 95%ile condition at both the upstream and downstream locations. An analysis of the ambient BOD concentrations excluding the elevated trend in 2022 identified that the BOD EQS for good status for BOD is exceeded for both the mean and 95%ile condition.

The mean EQS for high quality for orthophosphate is maintained at both locations and the 95%ile EQS for good indicative quality for orthophosphate is also maintained at both locations.



**Table 4-2 - Water Quality Sampling Point Statistics**

|                       | RS14B012310 (Upstream) |        | RS14B012460 (Downstream) |        |
|-----------------------|------------------------|--------|--------------------------|--------|
| Substance             | Mean                   | 95%ile | Mean                     | 95%ile |
| Ammonia (mg/l)        | 0.063                  | 0.139  | 0.069                    | 0.202  |
| BOD (mg/l)            | 1.805                  | 4.100  | 1.827                    | 4.279  |
| Orthophosphate (mg/l) | 0.020                  | 0.049  | 0.021                    | 0.058  |

Since the mean and/or the 95%ile EQS concentration for good status is on the limit for the upstream location and is exceeded at the downstream location for ammonia, ELVs cannot be set for effluent from the upgraded Mortarstown WWTP which would secure compliance with good status at the downstream point. This is due to upstream catchment pressures on water quality. As a result, the proposed ELV for ammonia is calculated with reference to the notionally clean condition as described in Section 2.4.

Since the mean and/or the 95%ile EQS concentration for good status is exceeded at the upstream location for BOD, ELVs cannot be set for effluent from the upgraded Mortarstown WWTP which would secure compliance with good status at the downstream point. This is due to upstream catchment pressures on water quality. As a result, the proposed ELV for BOD is calculated with reference to the notionally clean condition as described in Section 2.4.

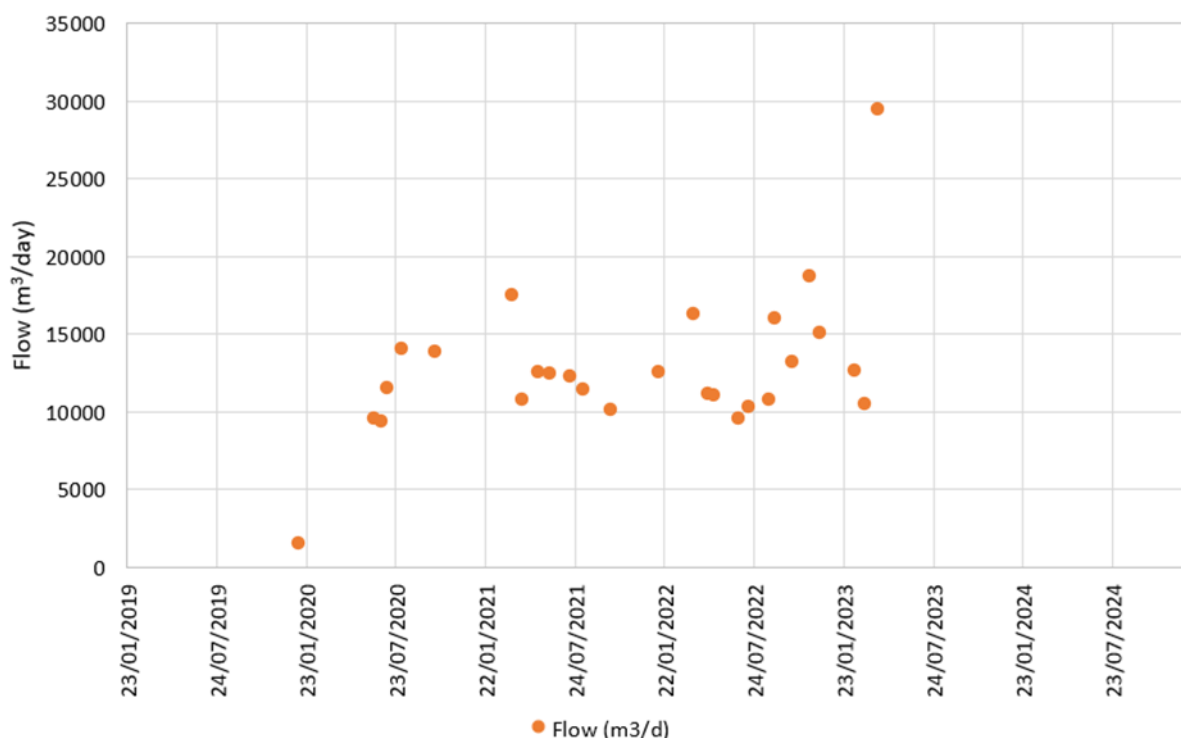




# 5. Mortarstown WWTP Effluent Flow and Quality Data

## 5.1 Effluent Flow Data

Figure 5-1 shows the daily flow rate data for Mortarstown WWTP from January 2020 to April 2023. The observed mean effluent flow is 12,700m<sup>3</sup>/d (0.147m<sup>3</sup>/s).



**Figure 5-1 - Mortarstown WWTP Effluent Flow Timeseries**

Flows at the New Bridge Barrow OPW gauge station were compared with the WWTP Effluent flow data and a weak positive correlation between the two data states was identified ( $R^2 = 0.354$ ). The correlation between river and effluent flow is likely due to rainwater and groundwater ingress into the Carlow sewerage system during times of wet weather, with the weakness in the correlation may be due to the existing upstream storm overflows at the Kilkenny Road Pump Station and the different rainfall response times of the Barrow River Catchment and the Carlow Town sewer catchment network. It is proposed that this weak correlation is not considered in the water quality impact assessment because the upgrade involves the installation of new stormwater storage tanks at the WWTP, which will generally decouple the effluent flow rates and the river flow rates.

The upgraded Mortarstown WWTP has been designed to allow for growth in the agglomeration, with a commensurate increase in effluent flow rates. The design horizon includes a projected increase in population served by the WWTP from the current population equivalent of 39,270 to a population of 58,500 over the next 25 years. Table 9 presents the current dry weather ( $Q_{80}$ ) effluent flow and anticipated future dry weather ( $Q_{80}$ ) effluent flow. The mean flow anticipated under this scenario are also given for comparison; these flows were calculated by



applying the PE flow scaling factor to the observed effluent flow dataset. The WWTP Design Flowrates have been calculated on the basis 1.25 x DWF with a unit flow of 225L/PE/day.

**Table 5-1 - Current and Future Design Effluent Flow Rates**

| Design Horizon                          | Current           |                   | 25-year           |                   |
|-----------------------------------------|-------------------|-------------------|-------------------|-------------------|
| PE Served                               | 39,270            |                   | 58,500            |                   |
| Flow Increase Factor                    | 1.00              |                   | 1.48              |                   |
| Effluent Flow Rates                     | m <sup>3</sup> /d | m <sup>3</sup> /s | m <sup>3</sup> /d | m <sup>3</sup> /s |
| Current Observed Dry Weather Flow (Q80) | 10,368            | 0.120             |                   |                   |
| Predicted Future Dry Weather Flow (Q80) |                   |                   | 15,344            | 0.177             |
| Current Observed Mean Flow              | 12,700            | 0.147             |                   |                   |
| Predicted Future Mean Flow              |                   |                   | 18,796            | 0.217             |
| Future Design Flow (1.25 x DWF)         |                   |                   | 16,416            | 0.190             |

## 5.2 Effluent Quality

Figure 5-2, Figure 5-3, and Figure 5-4, show the observed effluent quality data in terms of ammonia, BOD and orthophosphate concentration. As noted in Section 4.2, in line with typical water quality statistical analyses, values at or below LOD levels have been replaced with proxy values of 50% of the LOD when calculating statistical metrics. The effluent data shows compliance with the current ammonia ELV with over 85% of the samples having an Ammonia concentration less than 0.2mg/l. The effluent data shows compliance with the current BOD ELV with over 97% of the samples having a BOD concentration less than or equal to 6 mg/l. The effluent data shows compliance with the current orthophosphate ELV with over 93% of the samples having an orthophosphate concentration less than or equal to 0.5 mg/l.

Table 10 compares the average effluent concentration of substances limited by ELVs in Section 2.1.1 against observed 2020-2024 averages. Mortarstown WWTP complied with the relevant ELVs during this time period. There are weak correlations between effluent flow rate and effluent concentrations of ammonia ( $R^2=0.168$ ), BOD ( $R^2 = 0.023$ ) and orthophosphate concentrations ( $R^2=0.160$ ) showing that the current WWTP functions well under the observed range of effluent flow conditions.



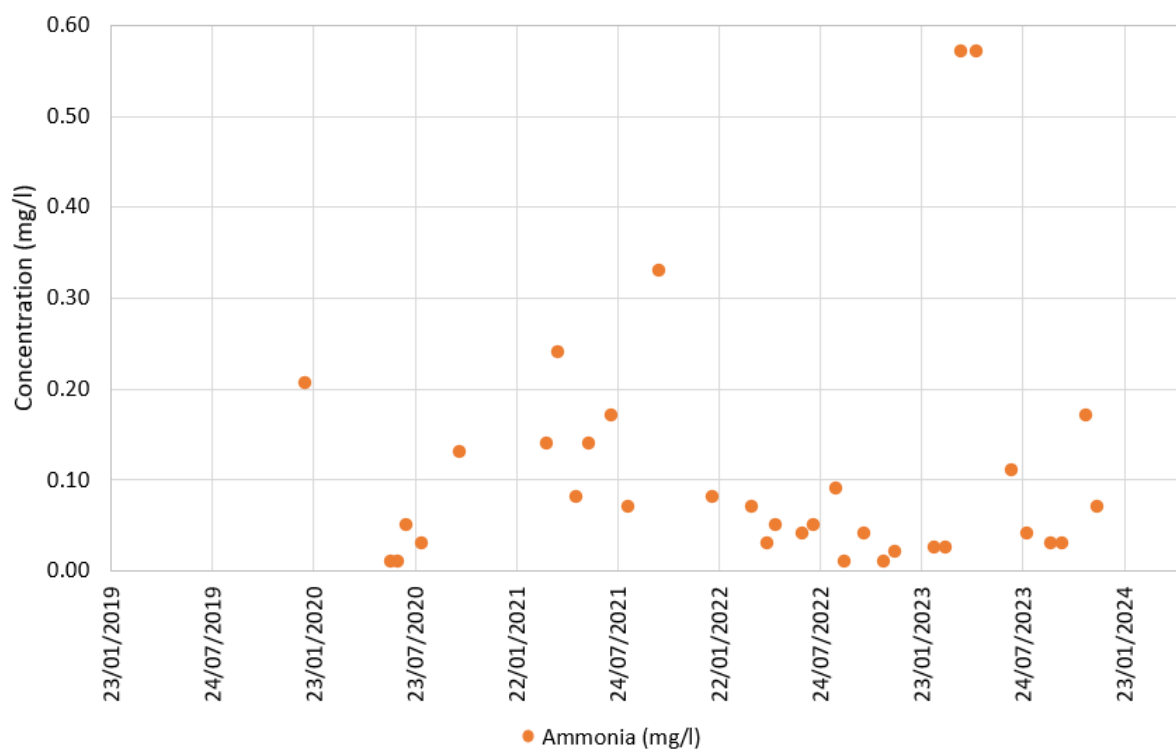


Figure 5-2 - Mortarstown WWTP Effluent Ammonia Concentrations

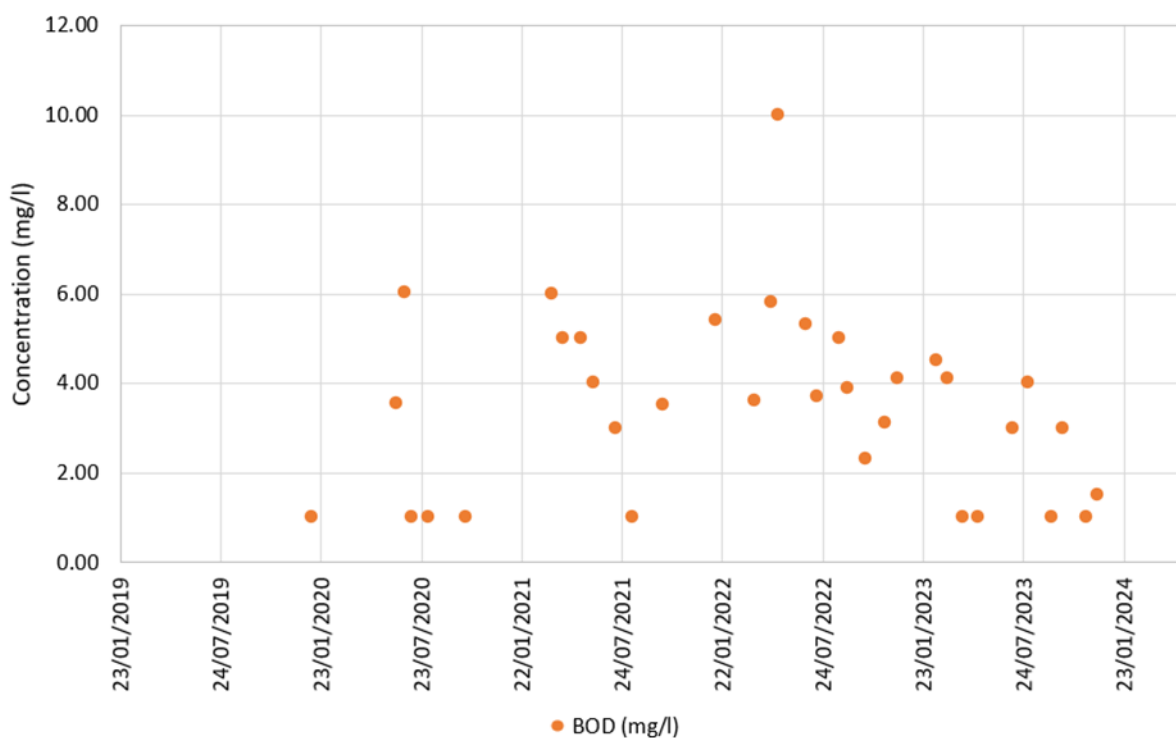
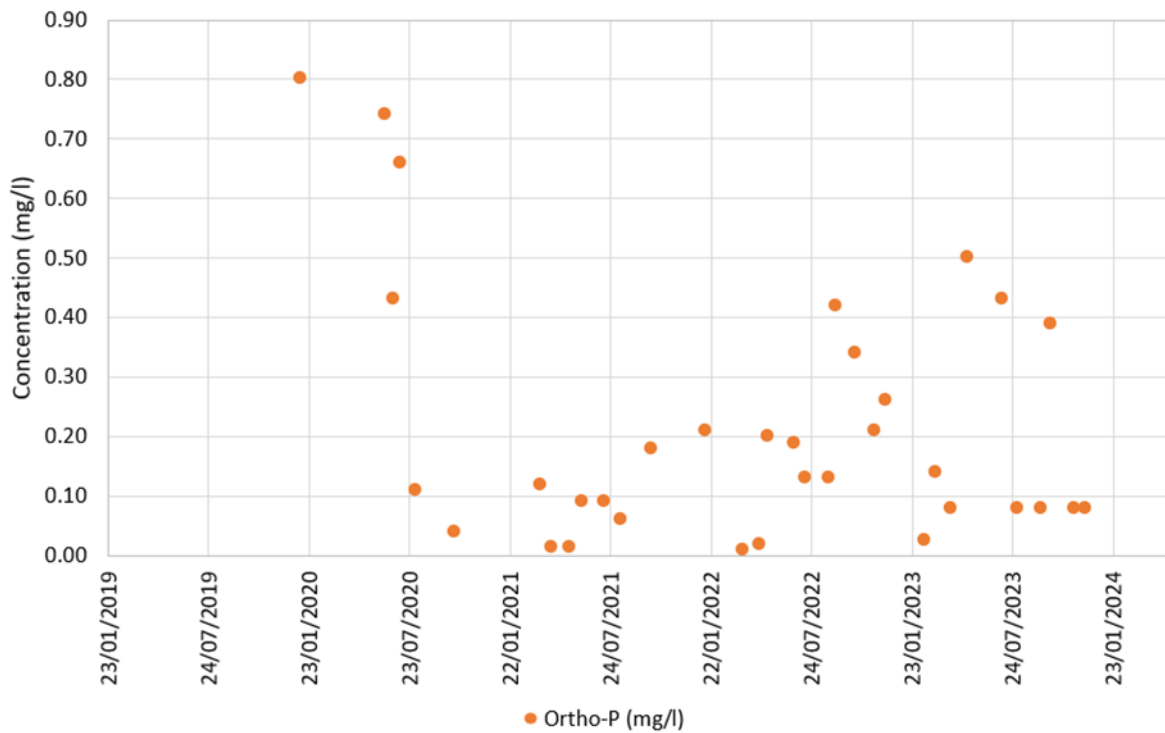


Figure 5-3 - Mortarstown WWTP Effluent BOD Concentrations





**Figure 5-4 - Mortarstown WWTP Effluent Orthophosphate Concentrations**

**Table 5-2 - Comparison Between Mortarstown WWTP ELVs and Monitored Effluent Quality**

| Parameter               | UWWTD Maximum Permitted Value | Current Mortarstown WWTP ELV | 2020-2024 Mortarstown WWTP Treated Effluent Mean |
|-------------------------|-------------------------------|------------------------------|--------------------------------------------------|
| COD (mg/l)              | 125                           | 125                          | -                                                |
| BOD (mg/l)              | 25                            | 15                           | 3.45                                             |
| Suspended Solids (mg/l) | 35                            | 35                           | -                                                |
| pH                      | --                            | 6 to 9                       | -                                                |
| Ammonia (mg/l)          | --                            | 2.0                          | 0.11                                             |
| Orthophosphate (mg/l)   | --                            | 0.8                          | 0.216                                            |
| Total Phosphorus (mg/l) | 1.00                          | 1.00                         | -                                                |





## 6. Water Quality Impact Assessment

The Tiered Assessment approach outlined in Section 1.1 has been applied to the Mortarstown WWTP discharge in the Sections below.

### 6.1 Tier 0 and 1 Assessments

The Tier 0 and 1 Assessments are initial screening checks to identify substances which require impact assessment. The stages are as follows:

- **Tier 0:** check to see if the effluent is likely to contain a contaminant of concern. If so, check to see if the contaminant is present at levels above the EQS.
- **Tier 1:** Check to see if discharging the contaminant(s) of concern at levels above the EQS are likely to have a significant impact on the receiving waterbody given existing ambient concentrations.

Based on review of the legislative framework in Section 2, substances of concern in Mortarstown WWTP final treated effluent are ammonia, BOD and orthophosphate. Table 6-2 compares average effluent, ambient and EQS concentrations of the substances of concern.

**Table 6-1 - Effluent, Ambient and EQS Concentrations of Substances of Concern**

| Parameter             | Mean WWTP Monitored Effluent Concentration | u/s Mean Ambient Concentration (RS14B012310) | Environmental Quality Standard |
|-----------------------|--------------------------------------------|----------------------------------------------|--------------------------------|
| Ammonia (mg/l)        | 0.11                                       | 0.063                                        | 0.065                          |
| BOD (mg/l)            | 3.45                                       | 1.805                                        | 1.50                           |
| Orthophosphate (mg/l) | 0.216                                      | 0.020                                        | 0.035                          |

Table 6-1 shows that effluent concentrations at the existing Mortarstown WWTP for ammonia, orthophosphate and BOD exceed both ambient and EQS concentrations. This will continue at the upgraded WWTP and so these substances will require additional assessment at Tier 2. The pH of the effluent is, and will remain, within the permitted EQS range for rivers and this parameter is therefore screened out at Tier 0.

### 6.2 Tier 2a Assessment

An initial assessment of the downstream water quality impacts of the Mortarstown WWTP discharge has been made using the simple mass balance approach as set out in Section 1.1.1. Following the methodology of the Uisce Éireann Mass Balance Tool UÉ-AMT-FM-007 downstream mean and 95%ile water quality are predicted based on mean upstream river quality, current mean effluent flow rates and current mean effluent concentrations. The difference between the two calculations is the use of  $Q_{30}$  average river flows to predict mean downstream water quality and the  $Q_{95}$  low river flow to predict 95%ile downstream water quality. The predicted water quality is compared with observed values in Table 6-2.



**Table 6-2 - Downstream Water Quality Statistics predicted using Simple Mass Balance Approach**

| Parameter             | Statistic | Upstream Observed | Downstream Predicted | Downstream Observed |
|-----------------------|-----------|-------------------|----------------------|---------------------|
| Ammonia (mg/l)        | Mean      | 0.063             | 0.063                | 0.069               |
|                       | 95%ile    | 0.139             | 0.064                | 0.202               |
| BOD (mg/l)            | Mean      | 1.805             | 1.81                 | 1.827               |
|                       | 95%ile    | 4.100             | 1.83                 | 4.279               |
| Orthophosphate (mg/l) | Mean      | 0.020             | 0.021                | 0.021               |
|                       | 95%ile    | 0.049             | 0.024                | 0.058               |

As the ammonia WAC calculations and the BOD WAC calculations are undertaken on the basis of a Notionally Clean approach, the comparison of the downstream predicted concentrations (from the simple Mass Balance WAC Analysis sheet) for ammonia and BOD with the observed data in Table 6-2 is not applicable.

The results in Table 6-2 show that the simple mass balance approach results in a reasonable estimate of the downstream mean water quality for orthophosphate but underestimates the downstream 95%ile water quality for orthophosphate. This is because this approach adopts a simplified representation of upstream river water quality which is the controlling influence on downstream water quality at Mortarstown. As discussed in Section 4, the observed data indicates that the discharges from Mortarstown WWTP have limited impact on downstream water quality under the current scenario.

The simple mass balance approach can be used to calculate ELVs which would give a required downstream water quality corresponding to take-up of the intended percentage of the watercourse's wastewater assimilative capacity (Section 2.4) taking account of the future increases in flow as detailed in Section 5.1. Table 6-3 gives the ELVs required to deliver good indicative quality downstream of the existing discharge point, based on notionally clean upstream water quality (for ammonia and BOD) and using 30% of the available WAC.

**Table 6-3 - Required ELVs calculated using Simple Mass Balance Approach**

| Parameter             | Required ELV (Simple Mass Balance Approach), 25-year Design Horizon |
|-----------------------|---------------------------------------------------------------------|
| Ammonia (mg/l)        | 2.4                                                                 |
| BOD (mg/l)            | 42.5                                                                |
| Orthophosphate (mg/l) | 1.0                                                                 |

The ELVs calculated using the simple mass balance approach are achievable based on biological treatment with nitrification in a WWTP configuration similar to the current WWTP configuration and therefore a Monte Carlo (Tier 2b) analysis is not required Tier 2b Assessment.



## 6.2.1 Recommended ELVs

Recommended ELVs calculated on the basis of the simple mass balance approach, the UWWTD and the existing Discharge Licence are set out in Table 6-4 below. The calculation is carried out using effluent flows which have been increased by a 30% proportional increase in the dry weather capacity of the WWTP to reflect the increased 25-year design loading. The recommended ELVs are achievable using the existing treatment technology which is a cost-effective and proportionate approach to wastewater management while still providing the required protection of receiving water quality.

**Table 6-4 – Recommended ELVs for Mortarstown WWTP**

| Parameter | ELV                                              |
|-----------|--------------------------------------------------|
| Ammonia   | 2.0 (in line with the current Discharge Licence) |
| BOD       | 25 (in line with UWWTD)                          |
| Ortho-P   | 1.0                                              |

The Tier 2 assessment methods show that achievable ELVs can be applied to the discharge and sensitive receptors will not be impacted. Additional analysis of the mixing zone, as would be required in Tier 3 assessment is therefore not required.

## 7. Summary and Conclusions

Mortarstown WWTP discharges treated wastewater to the River Barrow, 2.2km south of Carlow Town. It is proposed to upgrade the WWTP to increase the treatment capacity of the WWTP; replace equipment and controls nearing the end of their working design life and address deficiencies related to stormwater storage volumes and shallow walled final settlement tanks.

A water quality impact assessment has been carried out in accordance with Uisce Éireann's Technical Guidance<sup>7</sup> to determine the current water quality impacts of the discharge and to calculate the required ELVs for the upgraded WWTP which will protect the environment from future deterioration in water quality under future loading scenarios, recognising the requirements of the legislative framework.

The water quality of the River Barrow upstream of the WWTP currently fails to comply with good status requirements with respect to BOD and is on the limit with respect to good status requirement for ammonia, therefore the "notionally clean" approach has been applied to BOD and ammonia to account for upstream pressures on water quality and to allow an assessment of the impacts of the WWTP discharges in accordance with the 'Polluter Pays' principle of the Water Framework Directive and in line with current licensing approaches under the WWDA regulations.

The Water Quality Impact Assessment utilised a tiered approach with initial screening at Tiers 0 and 1 followed by a Tier 2b assessment.

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<sup>7</sup> Interim Technical Guidance for Water Impact Assessments (Freshwater) Document No. AMT-GL-028).



The simple mass balance approach was used to calculate ELVs which take an appropriate percentage of the available assimilative capacity in the river, given upstream water quality and the sensitivity of the receiving environment. The calculation is carried out using effluent flows which have been specified to represent the future design capacity of the WWTP. The recommended ELVs calculated using the simple mass balance approach are shown in Table 7-1.

The ELVs determined using the simple mass balance method can be achieved using conventional WWTP technology. It is noted that the ELV for BOD is identified at 25mg/l as per the requirements of the UWWTD.

**Table 7-1 – Recommended ELVs for Mortarstown WWTP**

| Parameter | Recommended Mortarstown WWTP ELVs (mg/l)         |
|-----------|--------------------------------------------------|
| Ammonia   | 2.0 (in line with the current Discharge Licence) |
| BOD       | 25 (as per UWWTD)                                |
| Ortho-P   | 1.0                                              |



# APPENDICES



# Appendix A. Annual River Flow Statistics

Annual River Flow Statistics for the River Barrow at OPW New Bridge Barrow Guage Station

| Year         | Flow (m <sup>3</sup> /s) |      |                |                 |                 |                 |                 |                 |                 |                 |                 |                 |                 |
|--------------|--------------------------|------|----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
|              | Max                      | Min  | Q <sub>5</sub> | Q <sub>10</sub> | Q <sub>20</sub> | Q <sub>30</sub> | Q <sub>40</sub> | Q <sub>50</sub> | Q <sub>60</sub> | Q <sub>70</sub> | Q <sub>80</sub> | Q <sub>90</sub> | Q <sub>95</sub> |
| 2007         | 109.4                    | 11.8 | 67.5           | 49.5            | 31.6            | 22.9            | 18.2            | 16.4            | 15.4            | 14.2            | 13.3            | 12.8            | 12.5            |
| 2008         | 157.0                    | 8.1  | 105.9          | 77.6            | 56.0            | 46.8            | 39.4            | 33.4            | 28.3            | 24.3            | 19.6            | 13.7            | 11.9            |
| 2009         | 189.1                    | 13.2 | 122.2          | 85.0            | 52.1            | 39.7            | 31.8            | 27.6            | 24.8            | 22.4            | 20.4            | 18.2            | 17.4            |
| 2010         | 133.5                    | 7.9  | 75.5           | 62.8            | 37.7            | 30.0            | 24.9            | 21.8            | 18.5            | 15.5            | 12.9            | 11.4            | 9.9             |
| 2011         | 139.9                    | 8.3  | 68.4           | 51.0            | 36.8            | 28.2            | 22.5            | 17.4            | 13.6            | 12.6            | 11.8            | 11.0            | 10.4            |
| 2012         | 107.0                    | 12.6 | 79.2           | 62.5            | 45.5            | 38.9            | 33.6            | 28.5            | 25.9            | 22.0            | 18.9            | 16.1            | 14.3            |
| 2013         | 138.5                    | 6.4  | 64.0           | 48.6            | 33.0            | 24.8            | 22.1            | 18.4            | 14.1            | 11.1            | 9.8             | 8.9             | 8.1             |
| 2014         | 176.6                    | 7.5  | 107.7          | 80.1            | 62.6            | 52.9            | 38.7            | 29.7            | 25.2            | 16.5            | 12.8            | 10.3            | 8.2             |
| 2015         | 196.7                    | 3.7  | 110.5          | 70.1            | 45.1            | 33.0            | 25.4            | 19.8            | 15.8            | 11.0            | 9.7             | 8.9             | 8.5             |
| 2016         | 192.9                    | 8.3  | 96.5           | 63.8            | 40.9            | 26.9            | 19.7            | 16.5            | 14.2            | 12.4            | 11.0            | 10.2            | 9.2             |
| 2017         | 113.6                    | 7.2  | 64.6           | 46.7            | 31.8            | 24.4            | 20.2            | 16.3            | 14.3            | 12.3            | 11.0            | 9.5             | 8.5             |
| 2018         | 133.0                    | 6.7  | 76.7           | 64.7            | 48.4            | 38.2            | 26.9            | 17.8            | 11.1            | 9.0             | 8.2             | 7.8             | 7.5             |
| 2019         | 106.8                    | 6.1  | 74.1           | 64.2            | 44.1            | 32.3            | 25.7            | 23.2            | 19.7            | 15.5            | 12.3            | 9.5             | 8.5             |
| 2020         | 147.8                    | 10.1 | 110.6          | 66.3            | 50.0            | 36.9            | 29.5            | 24.9            | 19.1            | 15.4            | 13.4            | 12.1            | 11.5            |
| 2021         | 134.5                    | 7.5  | 97.2           | 65.6            | 40.2            | 27.5            | 22.0            | 17.1            | 15.1            | 12.8            | 11.2            | 9.9             | 8.8             |
| 2022         | 112.7                    | 8.7  | 87.1           | 70.8            | 55.3            | 40.2            | 24.1            | 26.7            | 21.5            | 19.5            | 16.1            | 12.6            | 11.4            |
| 2023         | 136.0                    | 11.3 | 94.4           | 68.4            | 53.2            | 42.0            | 32.6            | 31.5            | 26.3            | 22.4            | 17.7            | 13.6            | 12.6            |
| 2024         | 128.0                    | 8.5  | 83.6           | 64.0            | 53.2            | 43.9            | 37.0            | 26.7            | 18.7            | 13.4            | 11.9            | 11.2            | 10.9            |
| OPW<br>07-24 |                          |      | 85.4           | 65.3            |                 |                 |                 | 22.6            |                 |                 |                 | 10.0            | 8.8             |



# Appendix B. Mass Balance Calculation Spreadsheet



Waste Assimilative Capacity (WAC) Calculation (Rivers)

0.083427083

| Site Information         |                   |     |  | WWTP Licence Details & Current WWTP Performance    |        |  |  | Summary Statistics |                          |               |                              | EQS Values |                              |            |                            | High Status EQS |             | Good Status EQS |             |               |
|--------------------------|-------------------|-----|--|----------------------------------------------------|--------|--|--|--------------------|--------------------------|---------------|------------------------------|------------|------------------------------|------------|----------------------------|-----------------|-------------|-----------------|-------------|---------------|
| Licence code             | D0028-01          |     |  | Current Ammonia ELV (mg/l)                         | 2      |  |  | Ammonia            | Upstream Water Quality   |               | WAC Taken to High Status EQS |            | WAC Taken to Good Status EQS |            | % Through Good Status Band |                 | Mean (mg/l) |                 | Mean (mg/l) |               |
| WWTP Name                | Mortartstown WWTP |     |  | Current BOD ELV (mg/l)                             | 15     |  |  |                    | Mean (mg/l)              | 95kile (mg/l) | Mean (%)                     | 95kile (%) | Mean (%)                     | 95kile (%) | Mean (%)                   | 95kile (%)      | Mean (mg/l) | 95kile (mg/l)   | Mean (mg/l) | 95kile (mg/l) |
| Emission ID              |                   |     |  | Current Ortho-P ELV (mg/l)                         | 0.8    |  |  |                    | 0.063                    | 0.139         | 157                          | 154        | 96                           | 99         | 90                         | 98              | 1.3         | 2.2             | 1.5         | 2.6           |
| Watercourse Name         | River Barrow      |     |  | Current Effluent Mean Ammonia Concentration (mg/l) | 0.11   |  |  |                    | 1.805                    | 4.100         | 139                          | 186        | 120                          | 158        | 253                        | 475             | 0.025       | 0.045           | 0.035       | 0.075         |
| River Waterbody Code     | IE_SE_14_196      |     |  | Current Effluent Mean BOD Concentration (mg/l)     | 3.452  |  |  |                    | 0.020                    | 0.049         | 79                           | 109        | 56                           | 65         | -53                        | 13              |             |                 |             |               |
| EPA Waterbody Name       | River Barrow      |     |  | Current Effluent Mean Ortho-P Concentration (mg/l) | 0.216  |  |  | Ammonia            | Downstream Water Quality |               | WAC Taken to High Status EQS |            | WAC Taken to Good Status EQS |            | Use Notionally Clean?      |                 | Mean (%)    |                 | Mean (%)    |               |
| Upstream Quality Point   | RS148012310       |     |  | Current Average Effluent Flow (m³/s)               | 0.147  |  |  |                    | Mean (mg/l)              | 95kile (mg/l) | Mean (%)                     | 95kile (%) | Mean (%)                     | 95kile (%) | Mean (%)                   | 95kile (%)      | Mean        | 95kile          | Mean        | 95kile        |
|                          |                   |     |  |                                                    |        |  |  |                    | 0.069                    | 0.202         | 174                          | 224        | 107                          | 144        | YES                        | YES             |             |                 |             |               |
|                          |                   |     |  |                                                    |        |  |  |                    | 1.827                    | 4.279         | 141                          | 195        | 122                          | 165        | YES                        | YES             |             |                 |             |               |
|                          |                   |     |  |                                                    |        |  |  |                    | 0.021                    | 0.058         | 84                           | 129        | 60                           | 77         | NO                         | NO              |             |                 |             |               |
| Downstream Quality Point | RS148012460       |     |  | Current WWTP Hydraulic Capacity (m³/s)             | 0.117  |  |  | Ortho-P            | 0.021                    | 0.058         | 84                           | 129        | 60                           | 77         | NO                         | NO              |             |                 |             |               |
|                          |                   |     |  | Current Collected Load (PE)                        | 39,270 |  |  |                    |                          |               |                              |            |                              |            |                            |                 |             |                 |             |               |
| Summary of Required ELVs |                   |     |  | Future Design Horizon (year)                       | 2052   |  |  |                    |                          |               |                              |            |                              |            |                            |                 |             |                 |             |               |
| Ammonia                  |                   | 2.4 |  | Future Design Capacity (PE)                        | 58,500 |  |  |                    |                          |               |                              |            |                              |            |                            |                 |             |                 |             |               |
| BOD                      |                   | 42  |  | Future Design Average Effluent Flow (m3/s)         | 0.217  |  |  |                    |                          |               |                              |            |                              |            |                            |                 |             |                 |             |               |
| Ortho-P                  |                   | 1.0 |  |                                                    |        |  |  |                    |                          |               |                              |            |                              |            |                            |                 |             |                 |             |               |
| Calculation Date         |                   |     |  | 11/11/2024                                         |        |  |  |                    |                          |               |                              |            |                              |            |                            |                 |             |                 |             |               |

| River Flow | Present Day Flows           |        | Environmental Sensitivity Score        |         | Insert WAC           |        | Use Notionally Clean? |  | Upstream Concentration |               | Available WAC (absolute value) |               | Available WAC (% value) |               |
|------------|-----------------------------|--------|----------------------------------------|---------|----------------------|--------|-----------------------|--|------------------------|---------------|--------------------------------|---------------|-------------------------|---------------|
|            | Q <sub>95</sub> Flow (m³/s) | 9.513  |                                        |         | % WAC to be Utilised | % here |                       |  | Mean (mg/l)            | 95%ile (mg/l) | Mean                           | 95%ile (mg/l) | Mean                    | 95%ile (mg/l) |
|            | Average Flow (m³/s)         | 38.627 | Basis of Future WWTP Flow Calculations |         | Ammonia              |        |                       |  | 0.008                  | 0.018         | 0.057                          | 0.122         | 88                      | 87            |
|            |                             |        |                                        |         | BOD                  | 30     | Yes                   |  | 0.260                  | 0.440         | 1.240                          | 2.160         | 83                      | 83            |
|            |                             |        |                                        | Ortho-P | 30                   | No     |                       |  | 0.020                  | 0.049         | 0.015                          | 0.026         | 44                      | 35            |

| Target Downstream EQS |         |      |         | Final EQS Proxy Value (Predicted Downstream Concentration) |       |         |       | Equations                                                                                                        |  |  |  |
|-----------------------|---------|------|---------|------------------------------------------------------------|-------|---------|-------|------------------------------------------------------------------------------------------------------------------|--|--|--|
| Target Status Class   | Good    | Good | Good    | Ammonia                                                    | BOD   | Ortho-P |       | $D = [ (Q_{eff} \times C_{eff}) + (Q_{river} \times C_{river}) ] / (C_{eff} + Q_{river})$ mg/l                   |  |  |  |
|                       | Ammonia | BOD  | Ortho-P | Mean (mg/l)                                                | 0.025 | 0.632   | 0.024 | Where D = Downstream concentration (mg/l)                                                                        |  |  |  |
| Mean (mg/l)           | 0.065   | 1.5  | 0.035   | 95kile (mg/l)                                              | 0.055 | 1.088   | 0.057 | Q <sub>river</sub> = river flow (m³/s) & Q <sub>eff</sub> = discharge flow (m³/s)                                |  |  |  |
| 95kile (mg/l)         | 0.14    | 2.6  | 0.075   |                                                            |       |         |       | C <sub>river</sub> = mean upstream concentration (mg/l) & C <sub>eff</sub> = mean discharge concentration (mg/l) |  |  |  |

| Current Impact Calculation |                                      |                                                     |                                                  |      |         |                                                |      |         |                 | No. of Available Dilutions |  |
|----------------------------|--------------------------------------|-----------------------------------------------------|--------------------------------------------------|------|---------|------------------------------------------------|------|---------|-----------------|----------------------------|--|
| Design Year                | Population Equivalent Served by WWTP | WWTP Average Effluent Flow Rate (m <sup>3</sup> /s) | Predicted Downstream 95%ile Concentration (mg/l) |      |         | Predicted Downstream Mean Concentration (mg/l) |      |         | Q <sub>95</sub> |                            |  |
|                            |                                      |                                                     | Ammonia                                          | BOD  | Ortho-P | Ammonia                                        | BOD  | Ortho-P |                 |                            |  |
| 2022                       | 39,270                               | 0.147                                               | 0.063                                            | 1.83 | 0.023   | 0.063                                          | 1.81 | 0.020   | 64.58           | 262.24                     |  |
| 2037                       | 52,500                               | 0.197                                               | 0.064                                            | 1.84 | 0.024   | 0.063                                          | 1.81 | 0.021   | 48.31           | 196.15                     |  |
| 2052                       | 58,500                               | 0.219                                               | 0.064                                            | 1.84 | 0.024   | 0.063                                          | 1.81 | 0.021   | 43.35           | 176.03                     |  |

| Theoretical Current ELV Impact Calculation |                                      |                              |                                                  |      |         |                                                |      |         |                            |              |
|--------------------------------------------|--------------------------------------|------------------------------|--------------------------------------------------|------|---------|------------------------------------------------|------|---------|----------------------------|--------------|
| Design Year                                | Population Equivalent Served by WWTP | WWTP Design Flow Rate (m³/s) | Predicted Downstream 95%ile Concentration (mg/l) |      |         | Predicted Downstream Mean Concentration (mg/l) |      |         | No. of Available Dilutions |              |
|                                            |                                      |                              | Ammonia                                          | BOD  | Ortho-P | Ammonia                                        | BOD  | Ortho-P | Q <sub>95</sub>            | Average Flow |
| 2022                                       | 36,000                               | 0.117                        | 0.086                                            | 1.97 | 0.029   | 0.068                                          | 1.85 | 0.022   | 81.18                      | 329.62       |
| 2037                                       | 52,500                               | 0.171                        | 0.097                                            | 2.04 | 0.033   | 0.071                                          | 1.86 | 0.023   | 55.66                      | 226.03       |
| 2052                                       | 58,500                               | 0.190                        | 0.101                                            | 2.06 | 0.035   | 0.072                                          | 1.87 | 0.024   | 49.96                      | 202.84       |

| Required Effluent ELV Calculation |                                      |                                           |                                          |     |         |                                        |     |         |                            |              |                                    |      |         |
|-----------------------------------|--------------------------------------|-------------------------------------------|------------------------------------------|-----|---------|----------------------------------------|-----|---------|----------------------------|--------------|------------------------------------|------|---------|
| Design Year                       | Population Equivalent Served by WWTP | WWTP Design Flow Rate (m <sup>3</sup> /s) | Effluent ELV (mg/l) for 95%ile Condition |     |         | Effluent ELV (mg/l) for Mean Condition |     |         | No. of Available Dilutions |              | ELVs Required for Each Design Year |      |         |
|                                   |                                      |                                           | Ammonia                                  | BOD | Ortho-P | Ammonia                                | BOD | Ortho-P | Q <sub>95</sub>            | Average Flow | Ammonia                            | BOD  | Ortho-P |
| 2022                              | 36,000                               | 0.117                                     | 3.8                                      | 68  | 3.1     | 5.7                                    | 123 | 1.5     | 81.18                      | 329.62       | 3.8                                | 68.3 | 1.5     |
| 2037                              | 52,500                               | 0.171                                     | 2.6                                      | 47  | 2.1     | 3.9                                    | 85  | 1.1     | 55.66                      | 226.03       | 2.6                                | 47.2 | 1.1     |
| 2052                              | 58,500                               | 0.190                                     | 2.4                                      | 42  | 1.9     | 3.5                                    | 76  | 1.0     | 49.96                      | 202.84       | 2.4                                | 42.5 | 1.0     |
|                                   |                                      |                                           |                                          |     |         |                                        |     |         |                            |              |                                    |      |         |

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# Appendix F. Hydrodynamic Technical Report (IE Consulting, 2026)





# Mortarstown WWTP Upgrade

## Proposed Outfall Pipe & Headwall

### Hydrodynamic Technical Report



**March 2026**

# Mortarstown WWTP Upgrade

## Proposed Outfall Pipe & Headwall

# Hydrodynamic Technical Report

Client: Uisce Éireann

Location: Kilkenny Road, Mortarstown, County Carlow

Date: 05<sup>th</sup> March 2026

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## **Appendices**

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Appendix B. Particle Size Distribution

Appendix C. River Barrow Topographic Survey

Appendix D. Impact of Construction Stage on River Barrow Water Levels

Appendix E. Impact of Construction Stage on River Barrow Velocities

## 1. Introduction

IE Consulting was requested by AtkinsRéalis, on behalf of Uisce Éireann, to undertake a Hydrodynamic Analysis and Assessment in support of a planning application for the proposed Mortarstown Wastewater Treatment Plant (WWTP) upgrade project at Kilkenny Road, Mortarstown, Co Carlow. The primary objective of the proposed upgrade project is to deliver an upgraded WWTP to service the current and future agglomeration loading, ensuring the scheme complies with the Urban Wastewater Treatment Regulations 2001, the conditions enforced by the WWDA licence and to maintain the designation and status of the receiving waters.

This Hydrodynamic Analysis and Assessment has been undertaken specifically in relation to the proposed new outfall pipe and headwall element of the overall proposed upgrade project. In this regard it is proposed to replace the existing 600mm diameter outfall pipe with a new 900mm diameter gravity outfall pipe approximately 205m in length. The new outfall pipe will discharge to the main channel of the River Barrow Watercourse. The new outfall pipe will be constructed to the south side of the existing outfall, and a temporary cofferdam or similar structure will be required in order to construct the outfall pipe headwall within the area of the left overbank of the River Barrow. The proposed outfall pipe will enter the main channel of the River Barrow circa. 1.5m below the low water level.

The purpose of this assessment is to assess the potential short term (Construction Stage Scenario) and long-term (Operation Stage Scenario) impact of the proposed new outfall pipe and associated headwall to the existing hydrodynamic and hydrological regime of the River Barrow at this location.

The assessment and associated details presented herein includes for the following:

- Description of the River Barrow Catchment, its hydrological characteristics and physical catchment descriptors.
- Flow estimates within the River Barrow during both low flow and flood flow conditions.
- Assess and comment on the current substrate of the main channel of the River Barrow within the vicinity of the proposed outfall pipe and associated headwall.
- Development of a hydraulic model to assess the current hydrological and hydraulic conditions associated with the River Barrow at this location and assess the potential impacts of the proposed outfall pipe and associated headwall during the construction phase and operational phase.



- Assess the impact that the proposed outfall pipe and associated headwall may or may not have on the existing hydrodynamic and hydrological regime of the area, and determine if this has the potential to result in a change or alteration to the existing patterns of erosion, transport, or deposition of substrate within the River Barrow at this location.
- Quantify the minimum required height of the temporary cofferdam or other similar structure that will be required in order to construct the outfall pipe headwall within the area of the left overbank of the River Barrow.

An hydrologist from IE Consulting undertook a survey of the site area and surrounding catchment on the 25<sup>th</sup> of March 2025.

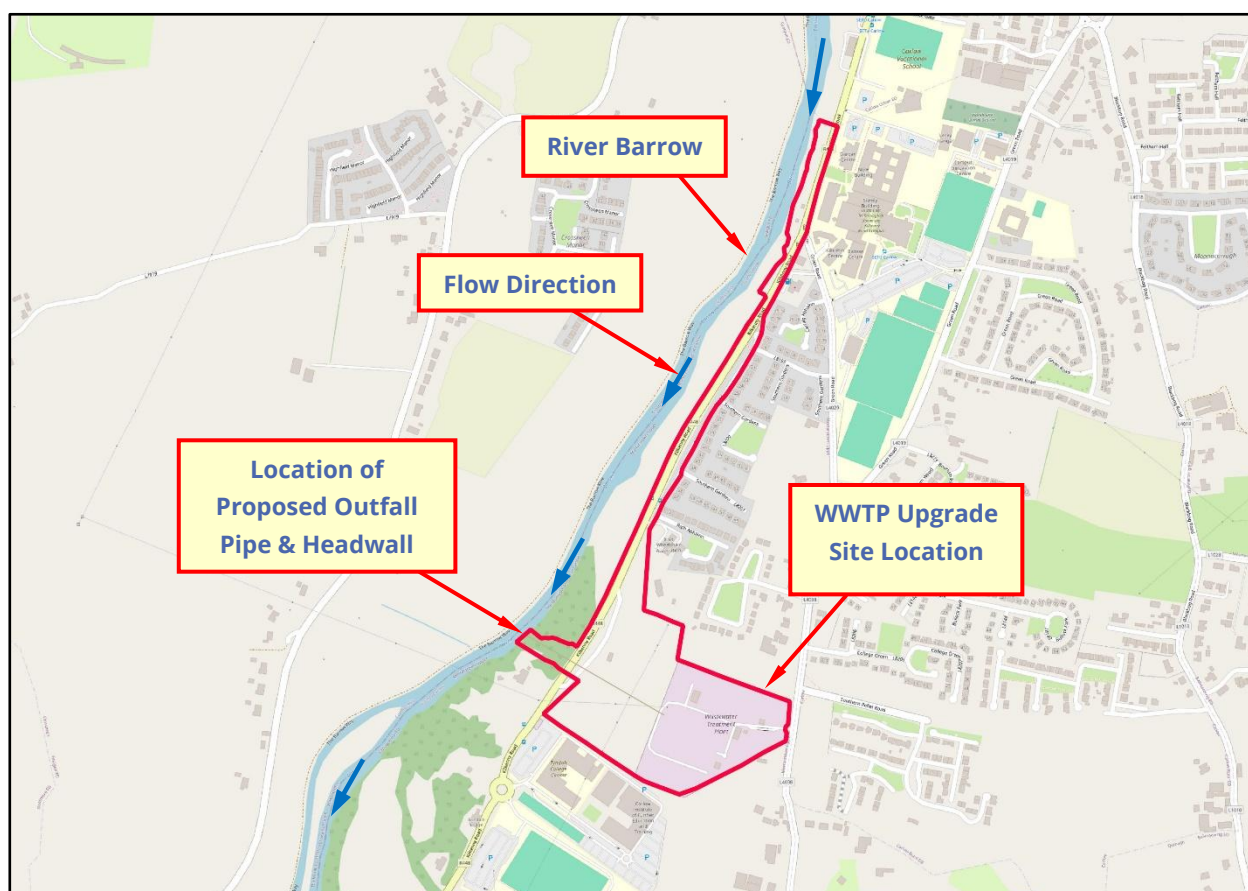
Quoted ground levels or estimated flood levels relate to Ordnance Datum (Malin) unless stated otherwise.

## 2. Study Area

### 2.1. General

The proposed outfall pipe and associated headwall is located on Kilkenny Road, Mortarstown, County Carlow, 2.2km south of Carlow Town. The site is bounded to the north and east by existing residential dwellings, to the south by Tyndall College Carlow and to the east by Kilkenny Road and the River Barrow. The proposed outfall to service the proposed WwTP development site is located in the south western corner of the site boundary, adjacent to the left hand bank of the River Barrow. The proposed outfall pipe will travel in a north western direction from the existing WwTP, underneath Kilkenny Road and will discharge into the River Barrow with a total length of approximately 210m.

The total area of the proposed WWTP development site is approximately 12.1265 ha. The location of the proposed WWTP development site is illustrated on *Figure 1* below and shown on *Drawing Number IE3120-001-A, Appendix A*.



**Figure 1 – Site Location**

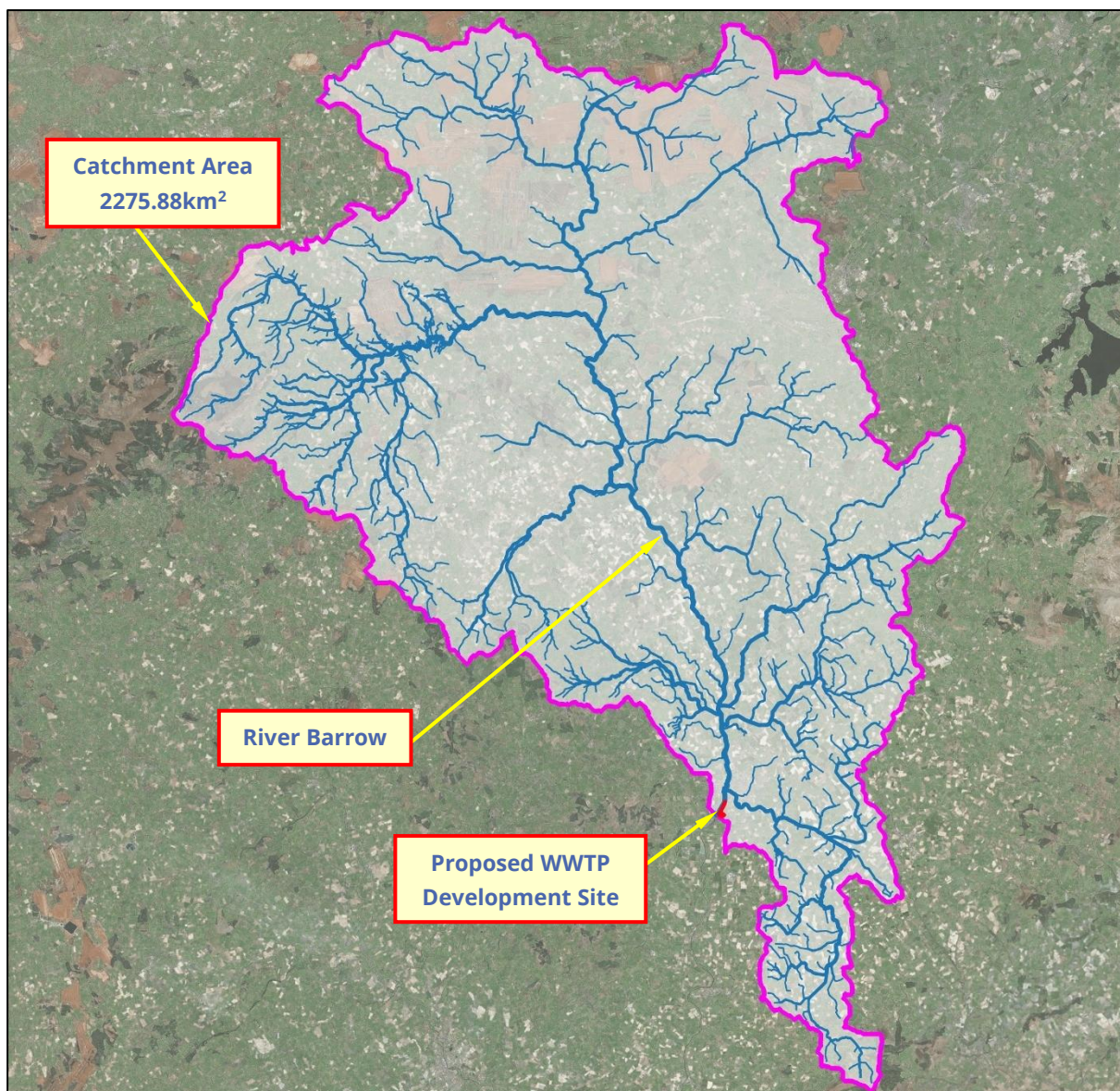
## 2.2. Topography

The most immediate and significant hydrological feature in the vicinity of the proposed WwTP outfall is the River Barrow located adjacent to the western boundary of the site, as illustrated in *Figure 1* above. At this location the River Barrow generally flows in a northeast to southwest direction.

The catchment area of the River Barrow was delineated and was found to be approximately 2275.88km<sup>2</sup> to a point located immediately downstream of the proposed WwTP outfall and as illustrated below in *Figure 2*. Assessment of the upstream catchment area indicates that the catchment is predominantly rural in nature with the urban fraction accounting for approximately 1.81% of the upstream catchment area.

The River Barrow originates in the Slieve Bloom Mountains in County Laois, initially flowing west to east through Portarlinton. It then shifts direction near Monasterevin, turning to flow north to south. From there, the river continues southward through towns and villages including Athy, Carlow, Muine Bheag, and Graiguenamanagh, eventually discharging into the sea near New Ross. An assessment of the upstream catchment area shows that it is largely rural, with urban areas comprising approximately 1.8% of the total.





**Figure 2 - River Barrow Catchment Area**

The lands of the proposed WwTP development site itself slopes gently from the east to the west towards the River Barrow. The ground drops more steeply along the western boundary of the proposed WwTP development site, next to the River Barrow. Existing ground elevations range from approximately 51.7m – 48.9m OD (Malin) within the eastern area of the site to 48.4m – 41.6 OD (Malin) in the western area of the site.

### 3. Substrate Analysis

To assess the current substrate within the River Barrow channel bed two sediment samples were collected by Murphy Geospatial on the 13/05/2025. Significant issues were encountered when attempting to acquire sufficient sediment volume from the main watercourse channel bed due to a lack of sediment transport and deposition potential at this location.

Deposition occurs whenever a river loses energy and the velocity falls. Within the vicinity of the proposed outfall pipe and associated headwall the reach length of the River Barrow watercourse is generally straight, with no significant meanders or changes of direction. The gradient of the watercourse channel is also significantly shallow at this location. As there is little change to the watercourse topography and gradient at this location, the flow velocity of the watercourse is low and relatively constant at this location. This in turn results in a low erosion, accretion, sediment transport and sediment deposition potential at this location.

Murphy Geospatial did acquire enough sediment material to allow for a substrate analysis to be completed by collecting sediment material within the main watercourse channel, at and upstream and downstream of the location of the proposed outfall pipe and associated headwall.

The collected sediment material is generally described as a dark brown/black saturated fine silt clay with numerous twigs and a strong organic odour. Some of the material verges on being anaerobic, but only because of the fine particle size and its saturated state, rather than any contamination. It suggests a more sluggish part of the river rather than a fast flowing more aerated section.

The collected sediment material was submitted for laboratory analysis to Ground Investigation & Geotechnical Specialists (IGSL) to assess the particle size distribution. The results of the analysis are listed below in *Table 1*.

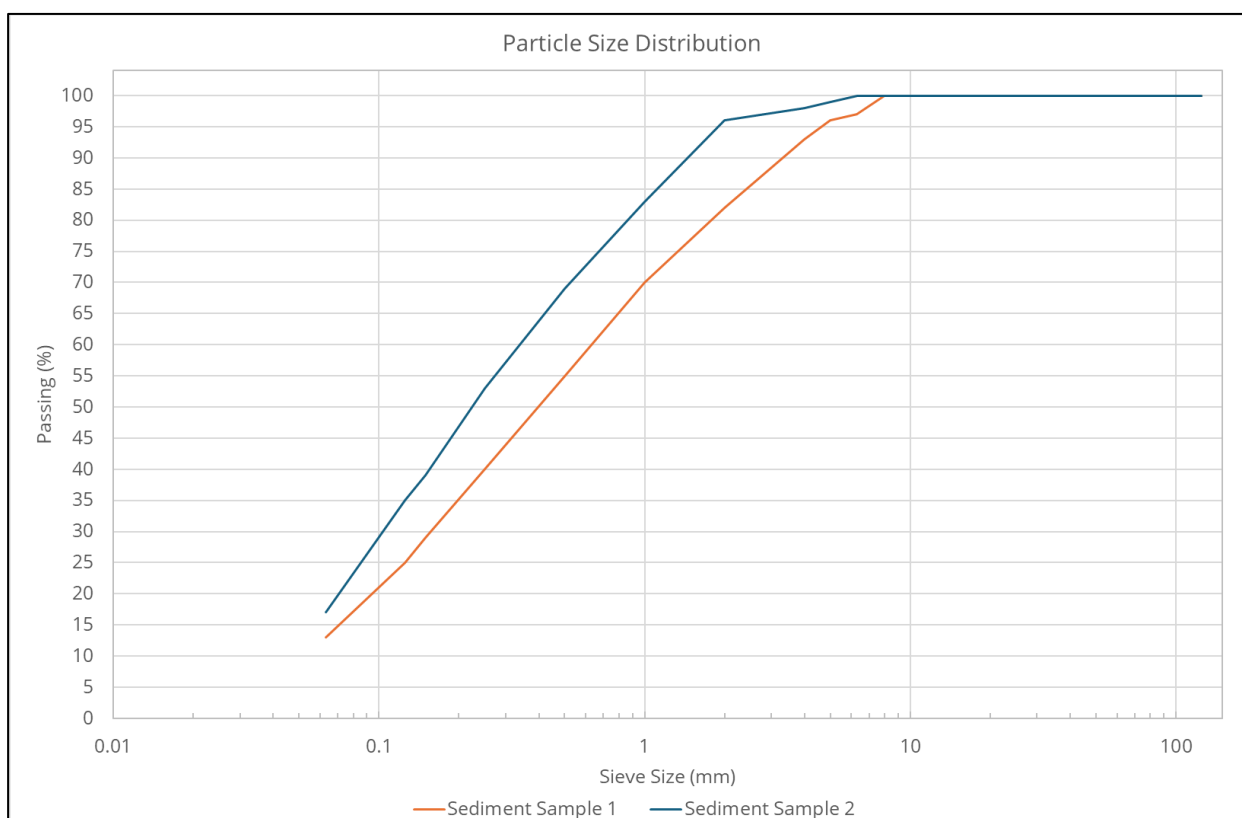
| Sieve Size (mm) | Grain size Description | Sediment Sample 1<br>% Passing | Sediment Sample 2<br>% Passing |
|-----------------|------------------------|--------------------------------|--------------------------------|
| 8               | Pebble                 | 100                            | 100                            |
| 6.3             |                        | 97                             | 100                            |
| 5               |                        | 96                             | 99                             |
| 4               |                        | 93                             | 98                             |



| Sieve Size (mm) | Grain size Description | Sediment Sample 1<br>% Passing | Sediment Sample 2<br>% Passing |
|-----------------|------------------------|--------------------------------|--------------------------------|
| 2               | Granule                | 82                             | 96                             |
| 1               | Very Course Sand       | 70                             | 83                             |
| 0.5             | Course Sand            | 55                             | 69                             |
| 0.25            | Medium Sand            | 40                             | 53                             |
| 0.15            | Fine sand              | 29                             | 39                             |
| 0.125           | Very fine sand         | 25                             | 35                             |
| 0.063           | Silt/ Clay (mud)       | 13                             | 17                             |

**Table 1 - Particle Size Table**

The particle size distribution grading of the collected sediment material is illustrated in *Figure 3* below.



**Figure 3 - Particle Size Distribution**

Based on the particle size distribution analysis presented above, the sediment within the main channel of the River Barrow at this location is mostly composed of between fine grained (grain size <2mm) and medium grained (grain size 0.063mm – 2mm). A copy of the particle size analysis is included in *Appendix B*.

## 4. Hydrological Assessment

A hydrological assessment has been undertaken in order to provide an estimation of the low flow regime and flood flow regime of the River Barrow at the location of the proposed outfall pipe and associated headwall.

The low flow and flood flow estimations have subsequently been utilised in the hydraulic modelling and analysis presented in *Section 5* of this study report.

### 4.1. Low Flow Estimation

The low flow regime within the River Barrow represents the baseline hydrological conditions under non-flood scenarios, specifically those associated with flow rates below the 50% AEP (1 in 2 Year) fluvial flood event.

For the purposes of this assessment, natural flow estimates have been utilised to evaluate the potential hydraulic impact, specifically in terms of water levels and velocities, associated with the construction of the proposed outfall pipe and associated headwall. As part of this assessment, two flow exceedance scenario thresholds were identified and calculated. These are listed in *Table 2* below.

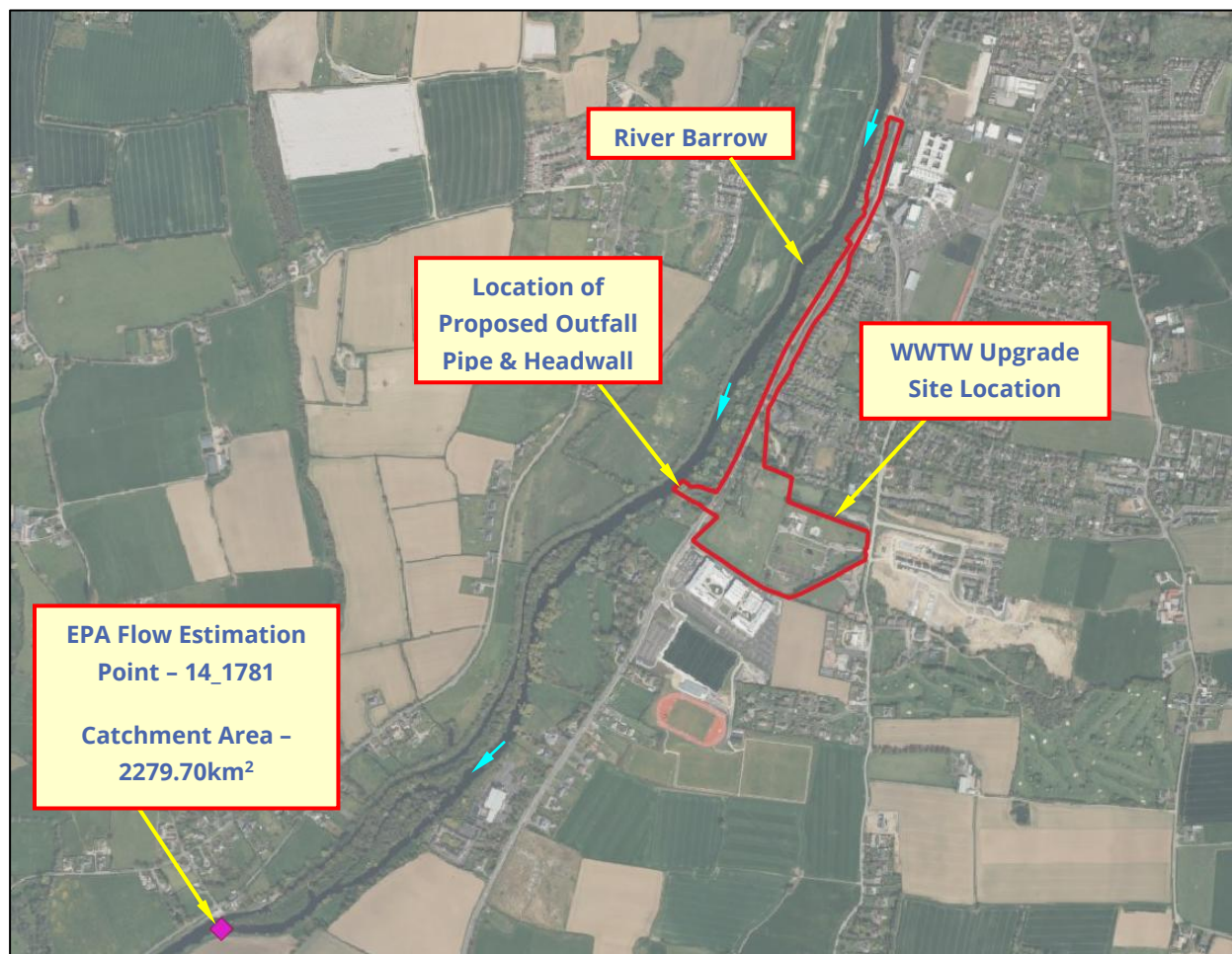
| Exceedance Scenario (%) | Description                                                        |
|-------------------------|--------------------------------------------------------------------|
| 5                       | Flow in the River Barrow that is exceeded 5% (5%ile) of the time   |
| 50                      | Flow in the River Barrow that is exceeded 50% (50%ile) of the time |

**Table 2 - Exceedance Events**

Two hydrometric gauges are situated on the River Barrow approximately 1.75 km upstream of the location of the proposed outfall pipe and associated headwall. However, a review of these gauge stations indicates that they record water level (stage) data only, with no associated flow (discharge) measurements. Consequently, they are considered unsuitable for deriving flow estimates required for this assessment.

In light of this limitation, the EPA Low Flow Duration Curve (LFDC) Tool was employed to estimate the 5%ile and 50%ile flow values. This tool generates flow percentile estimates for ungauged catchments based on catchment descriptors.

The outputs represent naturalised flow conditions and do not account for anthropogenic influences such as abstractions or effluent discharges. The location of the EPA-derived flow estimation point is illustrated below in *Figure 4*.



**Figure 4 - EPA Flow Estimation Point**

As illustrated in *Figure 4* above, the closest available flow estimation point from the EPA Low Flow Duration Curve Tool is located approximately 1.6km downstream of the location of the proposed outfall pipe and headwall. The percentage exceedance flows for the 5%ile and 50%ile events at this EPA Flow Estimation point are listed in *Table 3* below.

| Percentage Exceedance (%) | Flow (m <sup>3</sup> /s) |
|---------------------------|--------------------------|
| 5%ile                     | 97.78                    |
| 50%ile                    | 20.78                    |

**Table 3 – Natural River Flow Estimation at EPA Estimation Point 14\_1781**

As the EPA flow estimation point is situated downstream of the location of the proposed outfall pipe and headwall, the low flow exceedance values were area weighted to the site.

The catchment area to the location of the proposed outfall pipe and headwall is 2275.88km<sup>2</sup>, which is 3.82km<sup>2</sup> less than the catchment area to the EPA flow estimation point. Therefore, the percentage exceedance values are multiplied by 0.998 to represent the minor decrease in catchment area, the values of which are listed below in *Table 4*.

| Percentage Exceedance (%) | 16020 gauge flow data at gauge (m <sup>3</sup> /s) | Gauge Flow data area weighted to Weir (m <sup>3</sup> /s) |
|---------------------------|----------------------------------------------------|-----------------------------------------------------------|
| 5%                        | 97.818                                             | 97.622                                                    |
| 50%                       | 20.801                                             | 20.759                                                    |

**Table 4 - Area Weighted Flows**

In addition to the present day flows, the potential impact of climate change on the lows flows has been considered as a part of this assessment. A report issued by the EPA (Climate Change – Refining the Impacts for Ireland) states that the largest percentage increases in winter precipitation are expected to reach up to an increase of 20%. For this assessment it is assumed that the 20% increase in precipitation will correspond to a 20% increase in river flows, which is a conservative approach. The climate change low flows are listed below in *Table 5*.

| HEP                         | 5% ile Flow (m <sup>3</sup> /s) | 5% ile + CC Flow (m <sup>3</sup> /s) | 50% ile Flow (m <sup>3</sup> /s) | 50%ile + CC Flow (m <sup>3</sup> /s) |
|-----------------------------|---------------------------------|--------------------------------------|----------------------------------|--------------------------------------|
| River Barrow - HEP 14_184_4 | 97.622                          | 117.146                              | 20.759                           | 24.9108                              |

**Table 5 - Climate Change Low Flows**

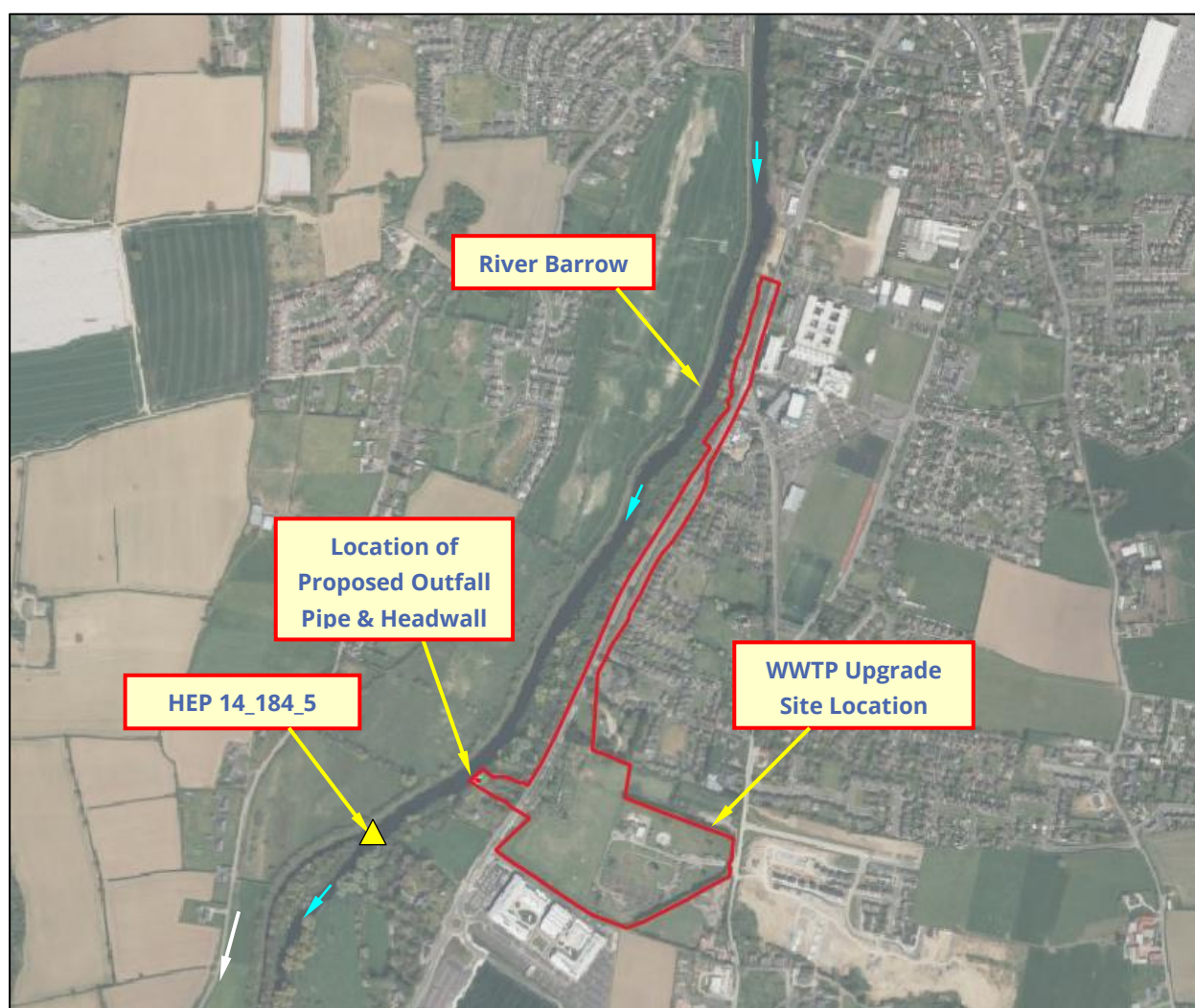


## 4.2. Flood Flow Estimation

### 4.2.1. Selection of Hydrological Estimation Point (HEP)

In order to provide an estimation of extreme fluvial flood flows in the River Barrow at the location of the proposed outfall pipe and headwall, a suitable hydrological estimation point (HEP) must be selected. This assessment and analysis is undertaken in consideration of the 50% AEP (1 in 2 year) and 1% AEP (1 in 100 year) fluvial flood flow in the River Barrow at this location.

To best represent the hydrological flows in the River Barrow, an HEP was selected close to the location of the proposed outfall pipe and headwall. The location of the selected HEP was obtained from the OPW Flood Estimation Package and is illustrated below in *Figure 5*.



**Figure 5 – Hydrological Estimation Point**

#### 4.2.1. Catchment Descriptors

Catchment descriptors for the HEP illustrated in *Figure 5* above were acquired from the OPW Flood Estimation Package and were then reviewed. The catchment descriptors for the selected HEP are listed below in *Table 6*.

| Catchment Descriptor         | HEP 14_184_5 |
|------------------------------|--------------|
| Area (km <sup>2</sup> )      | 2275.88      |
| FARL                         | 0.999        |
| S1085 (m/km)                 | 0.56446      |
| DRAIN2 (km/km <sup>2</sup> ) | 0.666        |
| ARTDRAIN2                    | 0            |
| BFISOIL                      | 0.66         |
| SAAR (mm)                    | 857.44       |
| URBEXT                       | 0.0181       |

**Table 6 - Catchment Descriptors at HEP 14\_184\_5**

#### 4.2.2. Estimation of Rural Q<sub>MED</sub>

The OPW South Eastern CFRAMS Hydrology Report was examined to determine the methodology used to derive the 1% AEP (1 in 100 year) flow rates associated with the River Barrow at this location.

The report states that the OPW Flood Studies Update (FSU) methodology was utilised to determine the peak flow within ungauged catchments. From this review the hydrological methods applied in the OPW South Eastern CFRAMS were deemed suitable for this hydrodynamic assessment. No suitable hydrometric gauges are located in close proximity to the location of the proposed outfall pipe and headwall and from which an estimate of flood flows can be extrapolated. Therefore the 7-parameter QMED equation was applied to the flow estimation point. This equation is listed below (*Equation 1*).

$$Q_{MED_{rural}} = 1.237 \times 10^{-5} AREA^{0.937} BFIsoils^{-0.922} SAAR^{1.306} FARL^{2.217} DRAIN2^{0.341} S1085^{0.185} (1 + ARTDRAIN2)^{0.408}$$

**Equation 1 - QMED Equation**

The catchment descriptors for the HEP selected are listed above in *Table 6*. The resultant QMED value is listed in *Table 7* below:

|                                | The River Barrow Flow (m <sup>3</sup> /s)<br>at HEP 14_184_5 |
|--------------------------------|--------------------------------------------------------------|
| Rural QMED (m <sup>3</sup> /s) | 130.517                                                      |

**Table 7 - QMED values at HEP**

#### 4.2.3. Pivotal Site Selection

No suitable hydrologically similar pivotal sites lie immediately upstream or downstream of the selected HEP. Therefore, the River Barrow is treated as an ungauged catchment at this location. A pivotal site is selected from a donor catchment based on hydrological similarity utilising the OPW FSU Flood Estimation Package. Of the possible donor pivotal sites, OPW FSU Station 14022 –Barrow New Bridge gauge was chosen as the most suitable pivotal sites due to the geographical and hydrological closeness to the subject site. OPW FSU station 14022 Barrow New Bridge gauge was also selected in the OPW South Eastern CFRAM study to calculate the relevant adjustment factor. The OPW South Eastern CFRAM Study developed a catchment run-off model (NAM) to develop an updated gauged QMED value as the original gauged QMED value was deemed to have a high level of uncertainty. The NAM model (Nedbor-Afstromings Model) is a module of the modelling software MIKE 11, which is capable of simulating river flow data based on input rainfall data. As a part of the OPW South Eastern CFRAM study the NAM model simulated flow at OPW FSU Station 14022 – Barrow New Bridge gauge based on the surrounding historic rainfall data from gauges and calculated an updated gauged QMED value of 126.8m<sup>3</sup>/s. The calculated QMED value based on catchment descriptors (Equation 1) was calculated at the OPW FSU station 14022 and was then divided by the updated gauged QMED value to determine the adjustment factor. The adjustment factor was then applied to the subject site QMED value at HEP 14\_184\_5 to determine the adjusted rural QMED. The adjusted rural QMED values are listed below in *Table 8*.

|                                     | The River Barrow Flow (m <sup>3</sup> /s)<br>at HEP 14_184_5 |
|-------------------------------------|--------------------------------------------------------------|
| Unadjusted QMED (m <sup>3</sup> /s) | 130.517                                                      |
| Adjustment Factor                   | 1.029                                                        |
| Adjusted QMED (m <sup>3</sup> /s)   | 134.33                                                       |

**Table 8 - Adjusted Rural QMED**

#### 4.2.1. Urbanisation

The effects of urbanisation can have a major impact on flood events. An increase in urbanisation normally results in a corresponding increase in surface runoff volumes due to more impervious surfaces and an increase in the speed of response. To account for this urbanisation an Urban Adjustment Factor (UAF) was calculated using the equation listed below as *Equation 2* and which is sourced from the OPW FSU Work Package 2.2 report (OPW 2009).

$$UAF = (1 + URBEXT)^{1.482}$$

**Equation 2 - Urban Adjustment Factor Equation**

The UAF and the corresponding urbanised QMED is listed below in *Table 9*.

|                                | River Barrow Flow (m <sup>3</sup> /s)<br>at HEP 14_184_5 |
|--------------------------------|----------------------------------------------------------|
| Rural QMED (m <sup>3</sup> /s) | 134.33                                                   |
| UAF                            | 1.027                                                    |
| Urban QMED (m <sup>3</sup> /s) | 137.95                                                   |

**Table 9 - Urban QMED Values**

#### 4.2.2. Growth Factors

In order to estimate the 50% AEP (1 in 2 year) and 1% AEP (1 in 100 year) peak flows in the River Barrow at this location, growth factors were derived using the same values applied to the OPW South Eastern CFRAM study. The growth factors from the OPW South Eastern CFRAMS study were calculated utilising a regional pooling group method and applying the Generalised Extreme Value (GEV) statistical distribution method. The resultant growth factors for the River Barrow are listed below in *Table 10*.

| Annual Exceedance Probability / AEP (%) | Growth Factors |
|-----------------------------------------|----------------|
| 50% (1 in 2 year)                       | 1              |
| 1% (1 in 100 year)                      | 2.005          |

**Table 10 - River Barrow Growth Factors**

The final peak model flows for this assessment are listed below in *Table 11*. These flows were derived by multiplying the growth factors illustrated above in *Table 10* for the River Barrow with the adjusted QMED values as listed in *Table 9* above.

| HEP          | Final Peak Model Flows (m <sup>3</sup> /s) |                           |
|--------------|--------------------------------------------|---------------------------|
|              | AEP<br>50% (1 in 2 year)                   | AEP<br>1% (1 in 100 year) |
| HEP 14_184_4 | 137.95                                     | 276.59                    |

**Table 11 - River Barrow 50% AEP & 1% AEP Peak Flows**

#### 4.2.3. Climate Change

Flooding is a natural process that can occur from a range of sources at any time in a wide variety of locations. Flooding can impact on people, communities, property, infrastructure, economy, environment, and our cultural heritage. It is likely that severe weather events and sea level rise due to climate change will have a considerable impact on flooding and flood risk in Ireland.

To assess the impacts of climate change on the proposed development the Climate Change Sectoral Adaptation Plan was inspected. This Plan considers the impacts of climate change on flooding and flood risk, as well as on flood risk management and what adaptation actions are required to ensure effective and sustainable management of flood risk into the future.

There are a variety of projections which quantify the impacts of climate change in the future. For this assessment the Mid-Range Future Scenario (MRFS) was applied to the predictive 50% AEP (1 in 2 Year) and 1% AEP (1 in 100 year) fluvial flows. The MRFS represents the typical or near to the general average future climate projections. The guidelines recommend that based on the MRFS projection a 20% increase should be applied to the peak fluvial flood flow. These are listed below in *Table 12*.

| HEP                            | 50% AEP<br>(1 in 2 year)<br>Flow (m <sup>3</sup> /s) | 50% AEP + CC<br>(1 in 2 year +<br>Climate Change)<br>Flow (m <sup>3</sup> /s) | 1% AEP<br>(1 in 100 year)<br>Flow (m <sup>3</sup> /s) | 1% AEP + CC<br>(1 in 100 year +<br>Climate Change)<br>Flow (m <sup>3</sup> /s) |
|--------------------------------|------------------------------------------------------|-------------------------------------------------------------------------------|-------------------------------------------------------|--------------------------------------------------------------------------------|
| River Barrow -<br>HEP 14_184_4 | 137.95                                               | 165.54                                                                        | 276.59                                                | 331.91                                                                         |

**Table 12 - Climate Change Flood Flows**



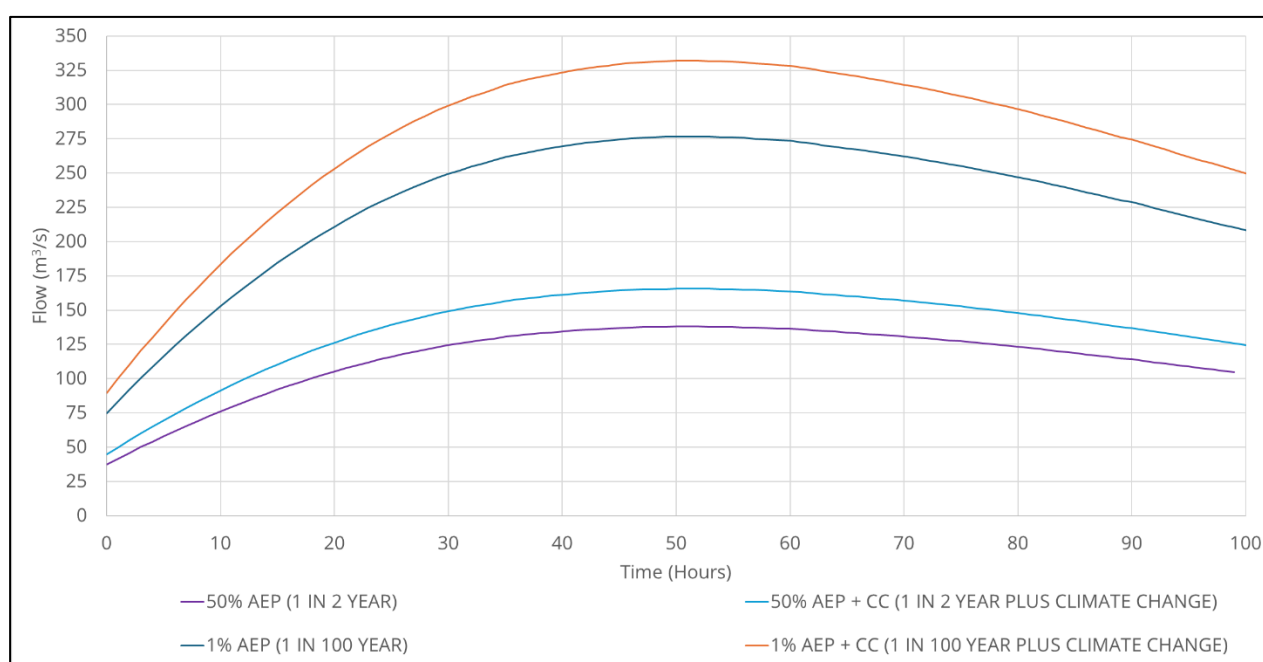
#### 4.2.4. Characteristic Hydrograph Transfer to Subject Site

The 50% AEP (1 in 2 year) and 1% AEP (1 in 100 year) peak flow hydrographs for the River Barrow at the HEP were derived utilising the OPW Flood Estimation Package.

The peak flows listed in *Table 13* below have subsequently been fitted onto the created hydrographs, as illustrated in Figure 6 below.

| Watercourse                    | 50% AEP<br>Flow (m <sup>3</sup> /s) | 50% AEP + CC<br>Flow (m <sup>3</sup> /s) | 1% AEP<br>Flow (m <sup>3</sup> /s) | 1% AEP + CC<br>Flow (m <sup>3</sup> /s) |
|--------------------------------|-------------------------------------|------------------------------------------|------------------------------------|-----------------------------------------|
| River Barrow - HEP<br>14_184_4 | 137.95                              | 165.54                                   | 276.59                             | 331.91                                  |

**Table 13 - River Barrow 50% AEP & 1% AEP Peak Flows**



**Figure 6 –River Barrow Flood Hydrographs**

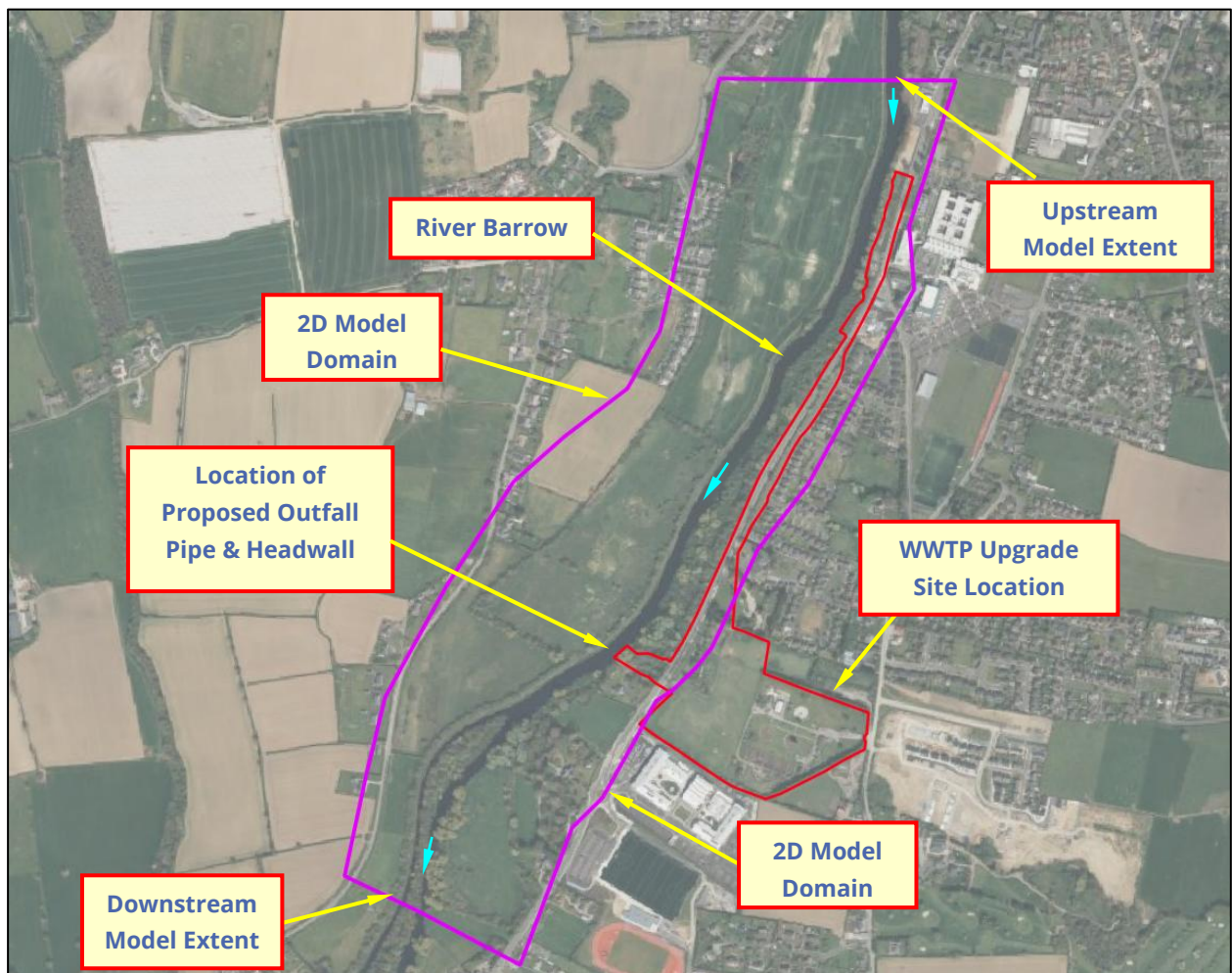
## 5. Hydraulic Modelling & Analysis

### 5.1. Introduction

A two dimensional (2D) hydraulic model was developed for the reach length of River Barrow at the location of the proposed outfall pipe and headwall.

The purpose of developing a hydraulic model is to estimate flood water levels and flow velocities at specific locations along the modelled reach representing the existing river channel and hydraulic structures on the River Barrow. The hydraulic model developed is based on an appropriate computer software package that utilises topographical information about the river and flood plain geometry, the hydraulic resistance characteristics (Manning's 'n') of the river and flood plain and appropriate boundary conditions at the upstream and downstream extent of the study area.

The extent of modelled watercourse reach length is illustrated in *Figure 7* below: -



**Figure 7 –River Barrow - Hydraulic Model Domain Extent**

## 5.2. Hydraulic Model Selection

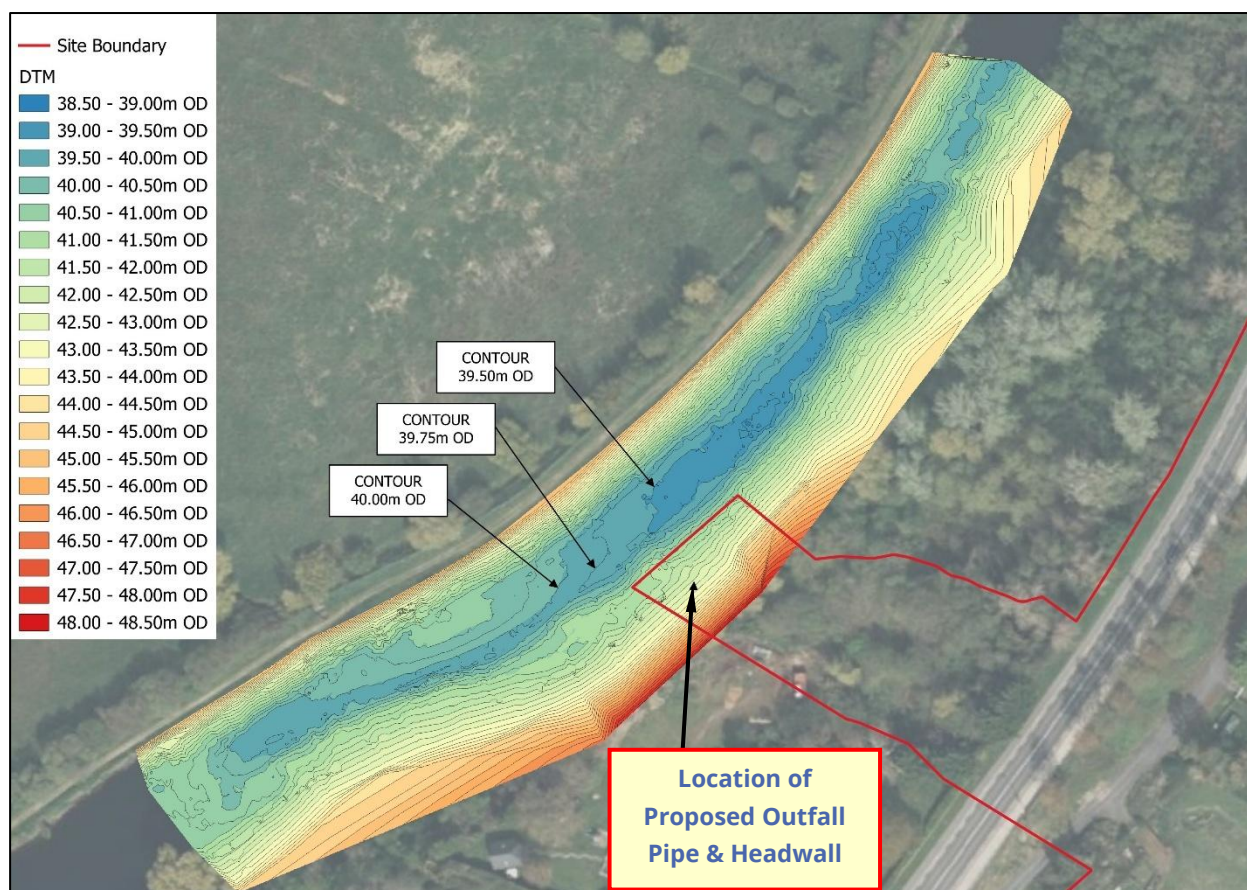
A number of hydraulic models are available which will predict flood levels for a given design flow. For this assessment the HEC-RAS hydraulic modelling package was employed. The HEC-RAS modelling package allows for one-dimensional (1D) and two-dimensional (2D) modelling of steady and unsteady state flow profiles and thematic mapping of flood plains and overland flow paths when required.

It also supports modelling of structures such as bridges, culverts, and weirs along with storage ponds. It is well regarded for use in the application of river and flood plain modelling. The model type utilised is a 2D model where the main channel of River Barrow and the left and right overbank lands is represented in the 2D domain.

## 5.3. Bathometric Survey Data

High-resolution site-specific survey data was acquired of the River Barrow within the vicinity of the proposed outfall pipe and associated headwall. The survey was gathered by Murphy Geospatial and consisted of detailed bed level data of the River Barrow, 130m upstream and downstream of the proposed outfall and associated headwall. The survey was completed in accordance with a survey specification written by IE Consulting and provided to Murphy Geospatial. A copy of the survey is included below in *Appendix C*.

Both a hard bed level and a soft bed level were requested to be collected, however, due to the lack of sediment on the River Bed, only a hard bed survey is available. The DTM and contour mapping developed for the modelled area is illustrated in *Figure 8* below. The hard bed survey was converted into a DTM which was then fed into the hydraulic model described in *Section 6* below. The highly detailed bathometric survey provided an extremely accurate representation of the River Barrow bed channel within the vicinity of the proposed outfall pipe and associated headwall.



**Figure 8 – River Topographic Survey - DTM and Contour Data**

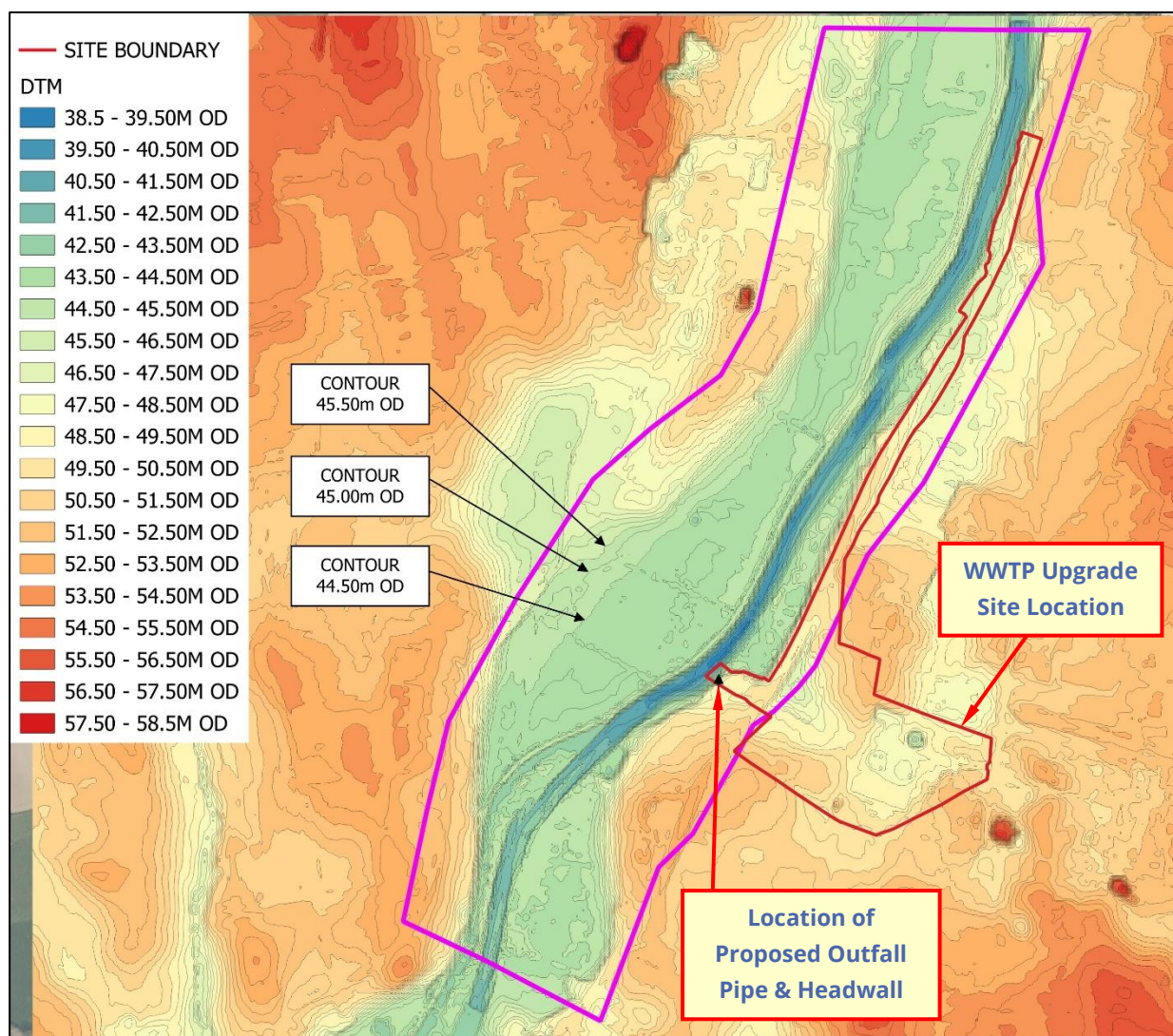
## 5.4. LiDAR Derived Digital Terrain Model & Contour Mapping

In order to assist the hydraulic modelling and analysis in the general area of the location of the proposed outfall pipe and headwall, and to enable an accurate representation of flood zone mapping and delineation to be developed, a detailed Digital Terrain Model (DTM) was developed for this location. From this data a detailed contour map was developed to encompass the area of the hydraulic model domain, including the area of the proposed outfall pipe and headwall, and surrounding lands.

The DTM and contour mapping was developed using aerial flown Light Detection & Ranging Data (LiDAR) which was commissioned by the OPW and acquired by Fugro in 2011. The LiDAR data was supplied in Irish Transverse Mercator (ITM) in TIF file format, at 2m resolution.

The DTM and contour mapping developed for the modelled area is illustrated in *Figure 9* below. The high-resolution river topographical survey discussed above in *Section 5.3* was also incorporated within this DTM.





**Figure 9 - DTM and Contour Data**

## 5.5. River Channel & Flood Plain Roughness Co-Efficients

The Manning's 'n' coefficient represents the hydraulic resistance to flow of the river channel or flood plain. The Manning's 'n' coefficients chosen are estimated from a visual inspection of the river channel and associated flood plain lands. Guidance is available on selecting appropriate Manning's 'n' values (from Chow 1959, French 1986); however, the Manning's 'n' coefficients are usually subsequently refined upon the development of the model by calibrating with any historical flooding data in the area, if available.

Table 14 below lists recommended river channel overbank land roughness co-efficients for various vegetation types.



| Type of Channel and Description                                                       | Minimum | Normal | Maximum |
|---------------------------------------------------------------------------------------|---------|--------|---------|
| <i>A. Natural Streams</i>                                                             |         |        |         |
| <b>1. Main Channels</b>                                                               |         |        |         |
| a. Clean, straight, full, no rifts or deep pools                                      |         |        |         |
| b. Same as above, but more stones and weeds                                           | 0.025   | 0.030  | 0.033   |
| c. Clean, winding, some pools and shoals                                              | 0.030   | 0.035  | 0.040   |
| d. Same as above, but some weeds and stones                                           | 0.033   | 0.040  | 0.045   |
| e. Same as above, lower stages, more ineffective slopes and sections                  | 0.035   | 0.045  | 0.050   |
| f. Same as "d" but more stones                                                        | 0.040   | 0.048  | 0.055   |
| g. Sluggish reaches, weedy, deep pools                                                | 0.045   | 0.050  | 0.060   |
| h. Very weedy reaches, deep pools, or floodways with heavy stands of timber and brush | 0.050   | 0.070  | 0.080   |
|                                                                                       | 0.070   | 0.100  | 0.150   |
| <b>2. Flood Plains</b>                                                                |         |        |         |
| a. Pasture no brush                                                                   |         |        |         |
| 1. Short grass                                                                        | 0.025   | 0.030  | 0.035   |
| 2. High grass                                                                         | 0.030   | 0.035  | 0.050   |
| b. Cultivated areas                                                                   |         |        |         |
| 1. No crop                                                                            | 0.020   | 0.030  | 0.040   |
| 2. Mature row crops                                                                   | 0.025   | 0.035  | 0.045   |
| 3. Mature field crops                                                                 | 0.030   | 0.040  | 0.050   |
| c. Brush                                                                              |         |        |         |
| 1. Scattered brush, heavy weeds                                                       | 0.035   | 0.050  | 0.070   |
| 2. Light brush and trees, in winter                                                   | 0.035   | 0.050  | 0.060   |
| 3. Light brush and trees, in summer                                                   | 0.040   | 0.060  | 0.080   |
| 4. Medium to dense brush, in winter                                                   | 0.045   | 0.070  | 0.110   |
| 5. Medium to dense brush, in summer                                                   | 0.070   | 0.100  | 0.160   |
| d. Trees                                                                              |         |        |         |
| 1. Cleared land with tree stumps, no sprouts                                          | 0.030   | 0.040  | 0.050   |
| 2. Same as above, but heavy sprouts                                                   | 0.050   | 0.060  | 0.080   |
| 3. Heavy stand of timber, few down trees, little undergrowth, flow below branches     | 0.080   | 0.100  | 0.120   |
| 4. Same as above, but with flow into branches                                         | 0.100   | 0.120  | 0.160   |
| 5. Dense willows, summer, straight                                                    | 0.110   | 0.150  | 0.200   |

**Table 14 - Manning's 'n' Values**

With reference to *Table 14* above, varying roughness co-efficients were applied to the hydraulic model to reflect the type and form of vegetation observed during the survey of the River Barrow undertaken by a hydrological engineer from IE Consulting.

In respect of the main channel of the River Barrow an applied roughness co-efficient of 0.040 was utilised, reflecting a channel that is generally clean and straight with some limited areas of stones and weeds. An applied flood plain roughness co-efficient of 0.060 (light brush) were utilised along the left bank of the River Barrow. A roughness co-efficient of 0.045 (open fields of grass) was applied to the remainder of the model domain.

*Figure 10* below illustrates the observed conditions along the modelled reach of the River Barrow.



**Figure 10 –River Barrow - Looking Downstream**

As illustrated in *Figure 11* below, the roughness values in the 2D model domain was represented utilising a GIS shapefile. Different areas within the model domain have different roughness values based on the land use characteristic. The Geological Survey of Ireland CORINE dataset was utilised to confirm the underlying land use.



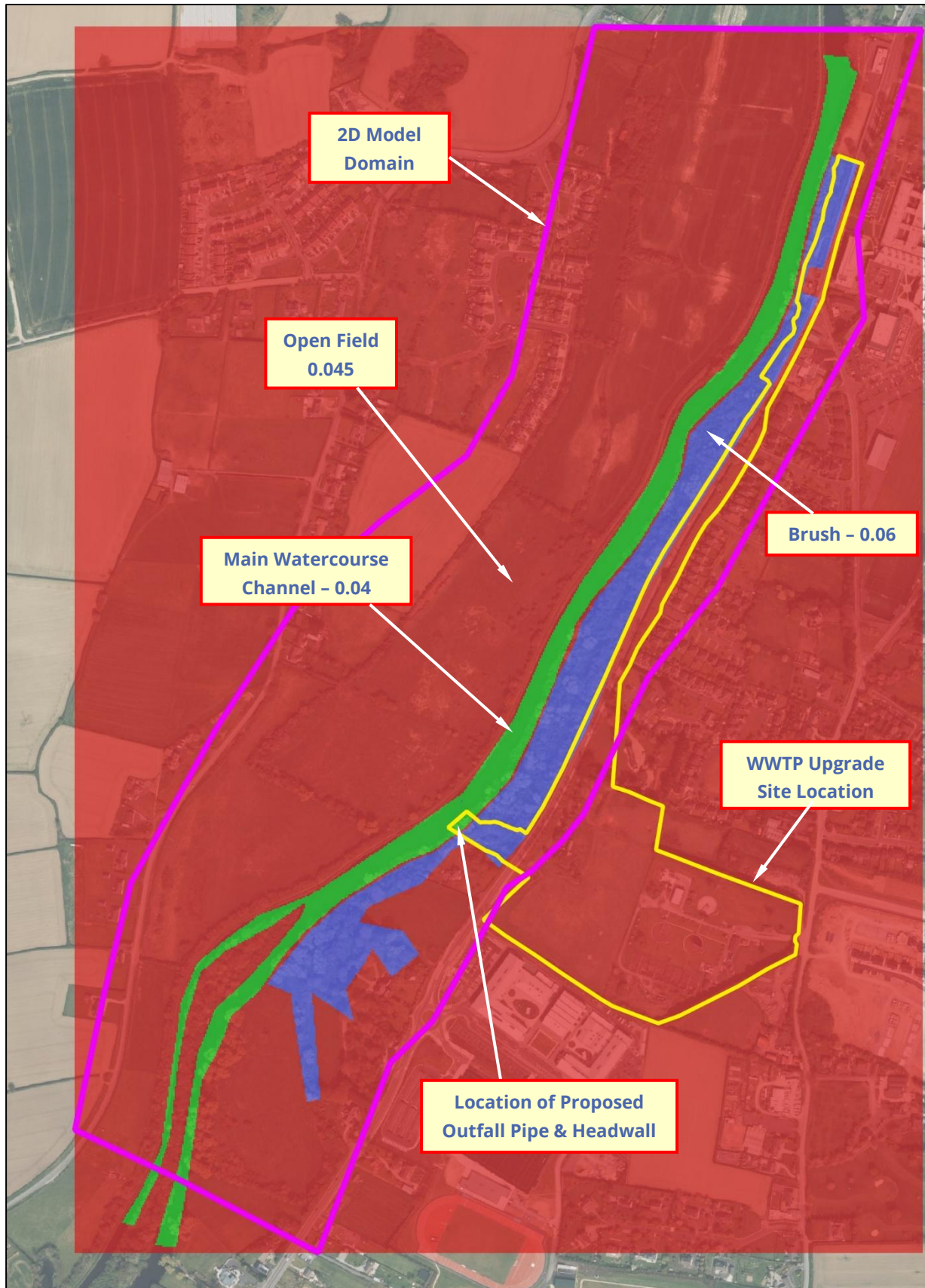


Figure 11 – 2D Roughness Values

## 6. Hydraulic Model Simulation Results

The hydraulic model was developed in order to provide a quantitative comparative analysis of the three phases of the proposed outfall pipe and associated headwall, these being the Existing Baseline Scenario, the Construction Stage Scenario and the Operational Stage Scenario.

- Existing Baseline Scenario – No proposed works undertaken. In this scenario the River Barrow watercourse is represented in the hydraulic model in its current configuration.
- Construction Stage Scenario – A temporary cofferdam or similar structure will be provided in order to construct the outfall pipe and headwall within the area of the left overbank of the River Barrow watercourse.
- Operation Stage Scenario – The proposed outfall pipe and associated headwall works are complete, and no further construction works are undertaken at this location.

The hydraulic simulation model was run for the Existing Baseline Scenario, the Construction Stage Scenario and the Operation Stage Scenario for the range of low flows and flood flows as listed below in *Table 15*.

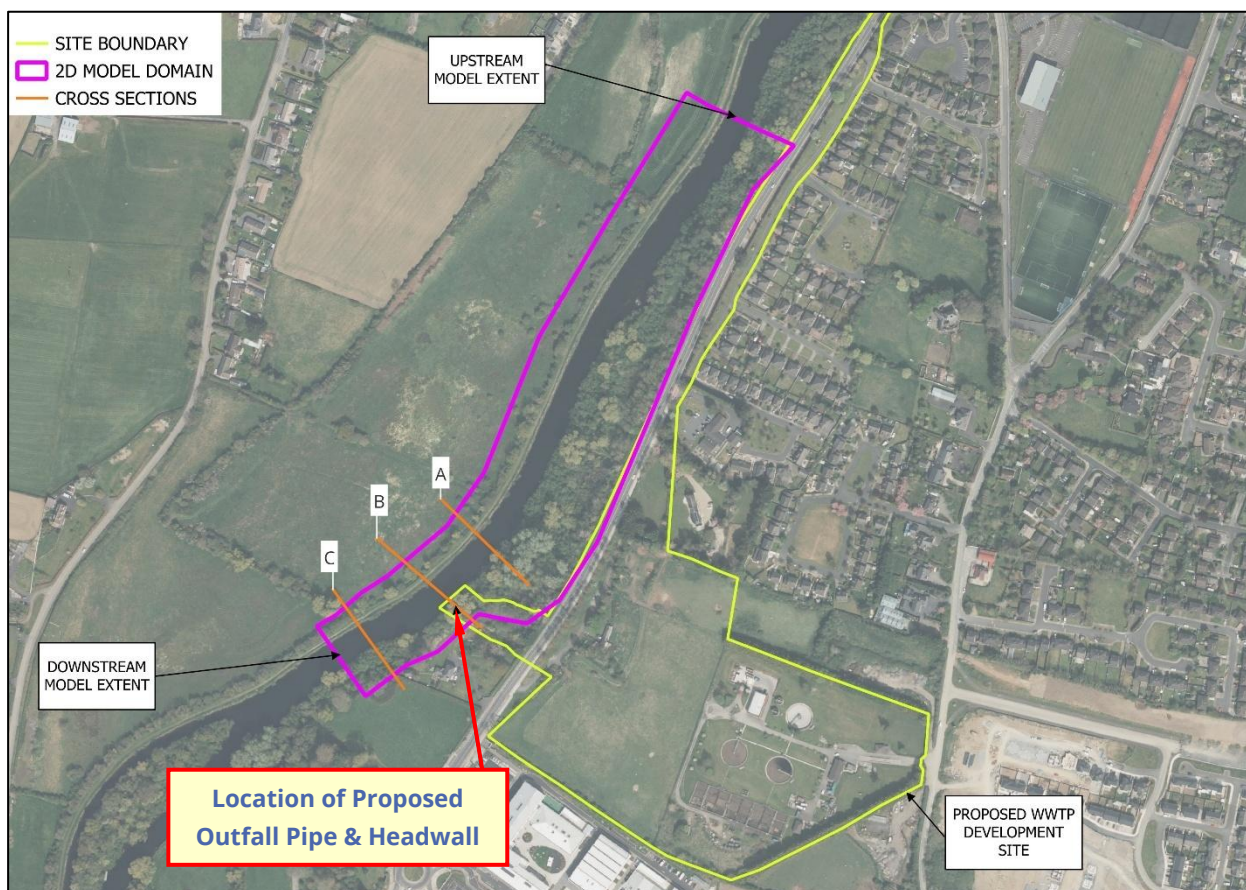
| Low Flows               | Flood Flows                                              |
|-------------------------|----------------------------------------------------------|
| 5%ile                   | 50% AEP (1 in 2 year)                                    |
| 5%ile + Climate Change  | 50% AEP + Climate Change (1 in 2 year + climate change)  |
| 50%ile                  | 1% AEP (1 in 100 year)                                   |
| 50%ile + Climate Change | 1% AEP + Climate Change (1 in 100 year + climate change) |

**Table 15 – Hydraulic Model Simulation Flows**

## 6.1. Existing Baseline Scenario

### 6.1.1. Low Flows

The 2D model domain was reduced for the low flow hydraulic model simulations in order to improve model run times. The 2D model domain utilised for the low flow model simulation is illustrated below in *Figure 12*.



**Figure 12 – Low Flow 2D Hydraulic Model Domain**

As illustrated in *Figure 12* above, three model cross sections are utilised in order to quantify modelled low flow water levels and flow velocities at and in the vicinity of the proposed outfall pipe and headwall – i.e. Cross Section ‘A’ – upstream of proposed outfall pipe and headwall, Cross Section ‘B’ – at location of proposed outfall pipe and headwall, Cross Section ‘C’ – downstream of proposed outfall pipe and headwall.

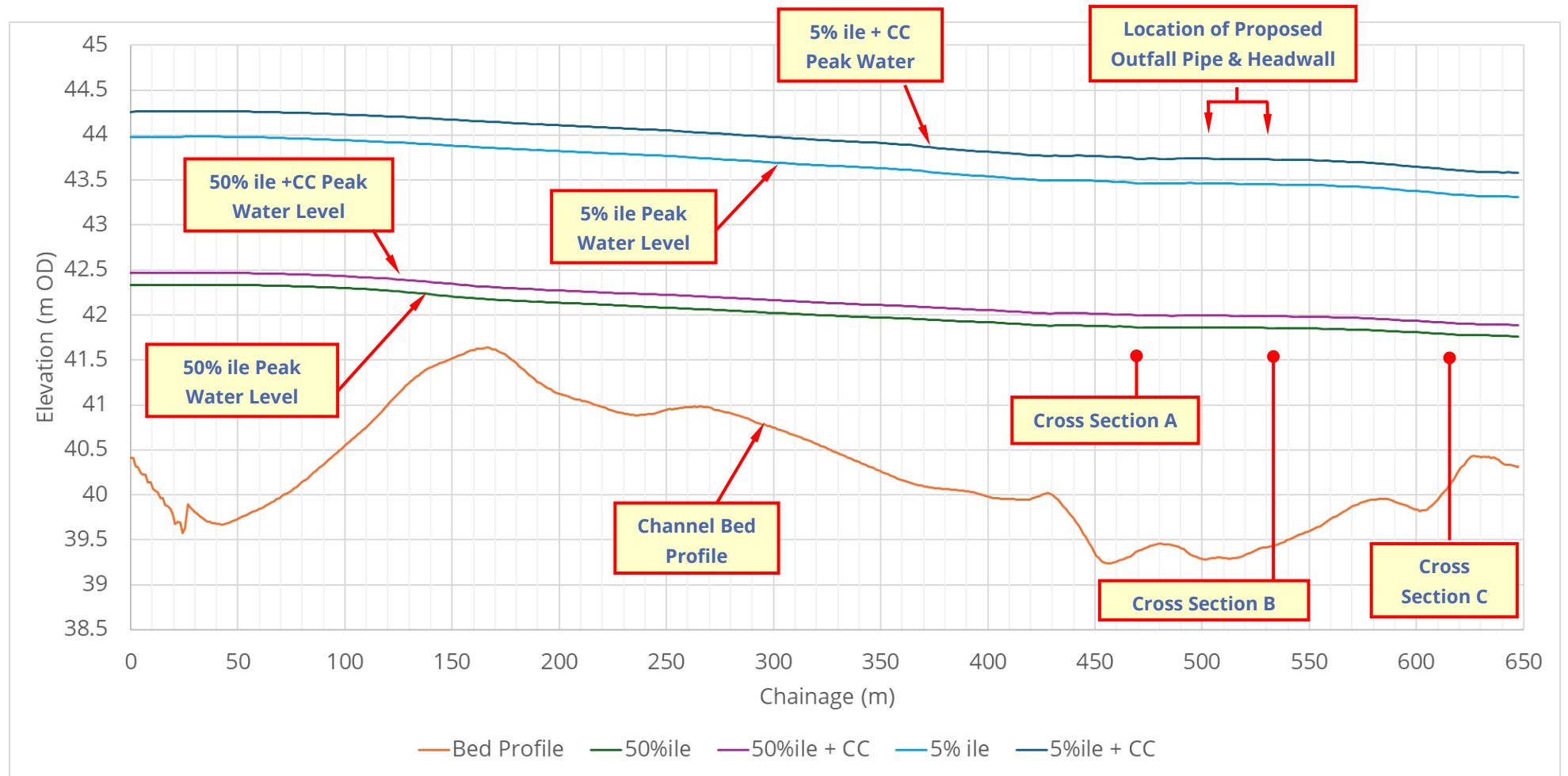


Table 16 below lists the predictive Existing Baseline Scenario 5%ile, 5%ile+CC, 50%ile and 50%ile + CC peak fluvial water levels at Cross Section 'A', Cross Section 'B' and Cross Section 'C' as outputted by the hydraulic simulation model

| Cross Section Label | 5%ile Peak Water Level (m OD) | 5%ile + CC Peak Water Level (m OD) | 50%ile Peak Water Level (m OD) | 50%ile + CC Peak Water Level (m OD) |
|---------------------|-------------------------------|------------------------------------|--------------------------------|-------------------------------------|
| A                   | 43.47                         | 43.74                              | 41.87                          | 42.00                               |
| B                   | 43.46                         | 43.73                              | 41.86                          | 41.99                               |
| C                   | 43.36                         | 43.63                              | 41.79                          | 41.92                               |

**Table 16 - Predictive 5%ile, 5%ile+ CC, 50%ile & 50%ile + CC Flood Levels – Existing Baseline Scenario**

Figure 13 below illustrates the longitudinal hydraulic model profile of the predictive Existing Baseline Scenario 5%ile, 5%ile+CC, 50%ile and 50%ile + CC water levels along the modelled reach of the River Barrow.



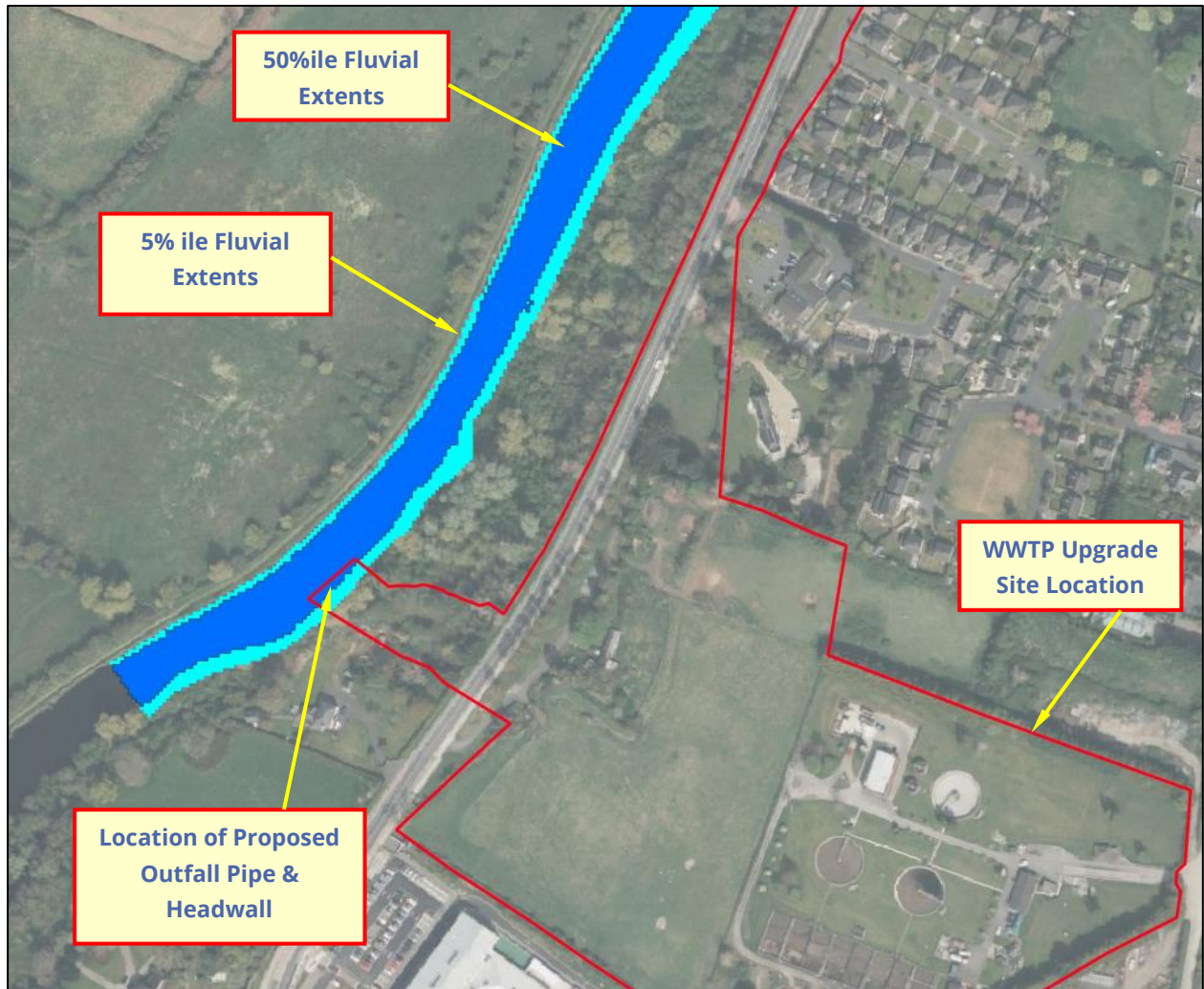
**Figure 13 – River Barrow – Longitudinal Hydraulic Profile – Existing Baseline Scenario**

Table 17 below list the predictive Existing Baseline Scenario 5%ile, 5%ile+CC, 50%ile, and 50%ile + CC peak flow velocities at Cross Section 'A', Cross Section 'B' and Cross Section 'C' as outputted by the hydraulic simulation model.

| Cross Section Label | 5%ile Peak Velocity (m/s) | 5%ile + CC Peak Velocity (m/s) | 50%ile Peak Velocity (m/s) | 50%ile + CC Peak Velocity (m/s) |
|---------------------|---------------------------|--------------------------------|----------------------------|---------------------------------|
| A                   | 1.632                     | 1.735                          | 0.956                      | 1.039                           |
| B                   | 1.560                     | 1.661                          | 0.634                      | 0.733                           |
| C                   | 1.679                     | 1.780                          | 0.918                      | 1.001                           |

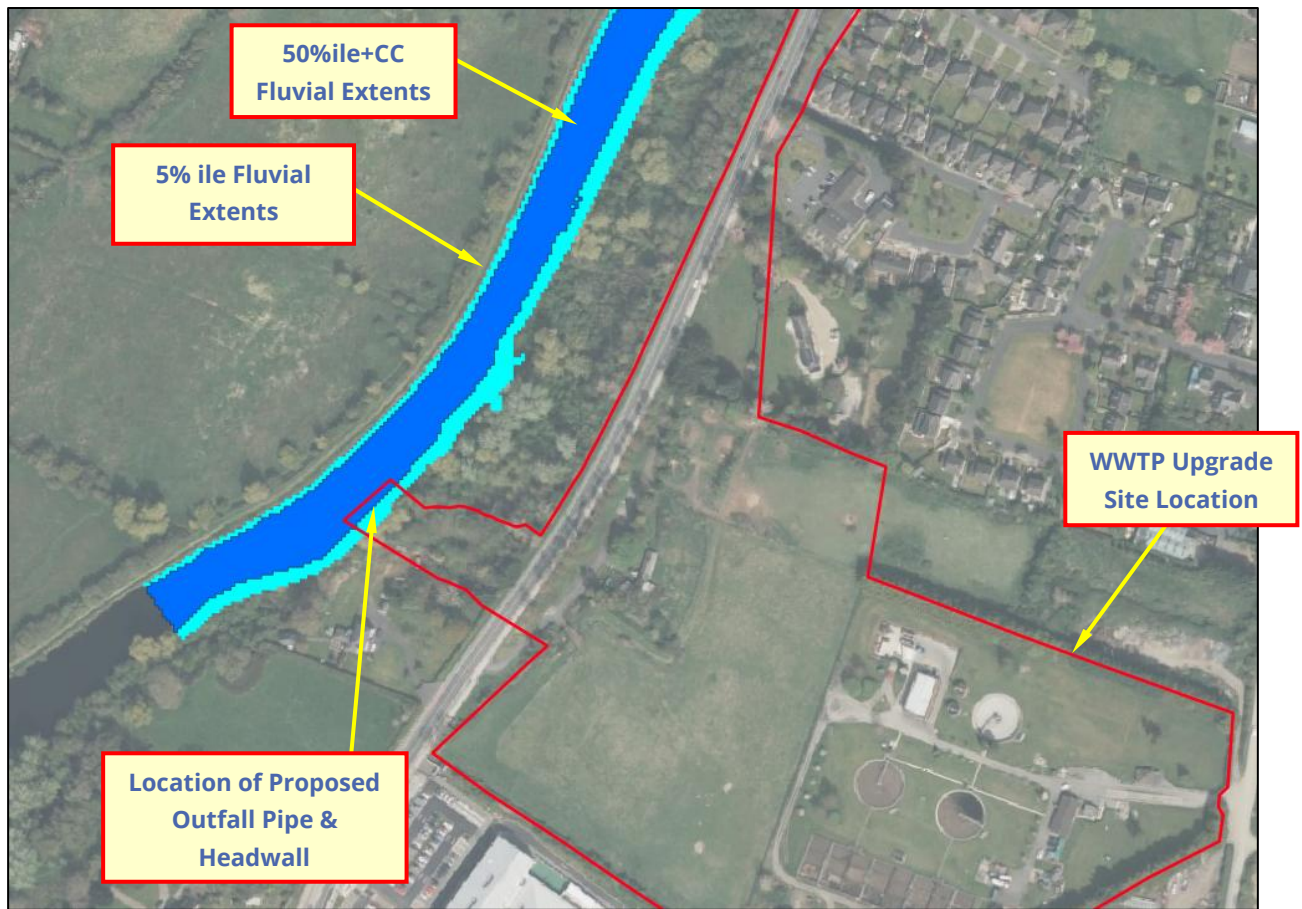
**Table 17 - Predictive 5%ile, 5%ile+ CC, 50%ile & 50%ile + CC Peak Velocities – Existing Baseline Scenario**

The 5%ile and 50%ile fluvial extents in consideration of the Existing Baseline Scenario as outputted by the hydraulic simulation model are illustrated in *Figure 14* below.



**Figure 14 - 50%ile & 5%ile Fluvial Extents – Existing Baseline Scenario**

The 5%ile+CC and 50%ile+CC fluvial extents in consideration of the Existing Baseline Scenario as outputted by the hydraulic simulation model are illustrated in *Figure 15* below.



**Figure 15 - 5%ile+CC & 50%ile+CC Fluvial Extents – Existing Baseline Scenario**

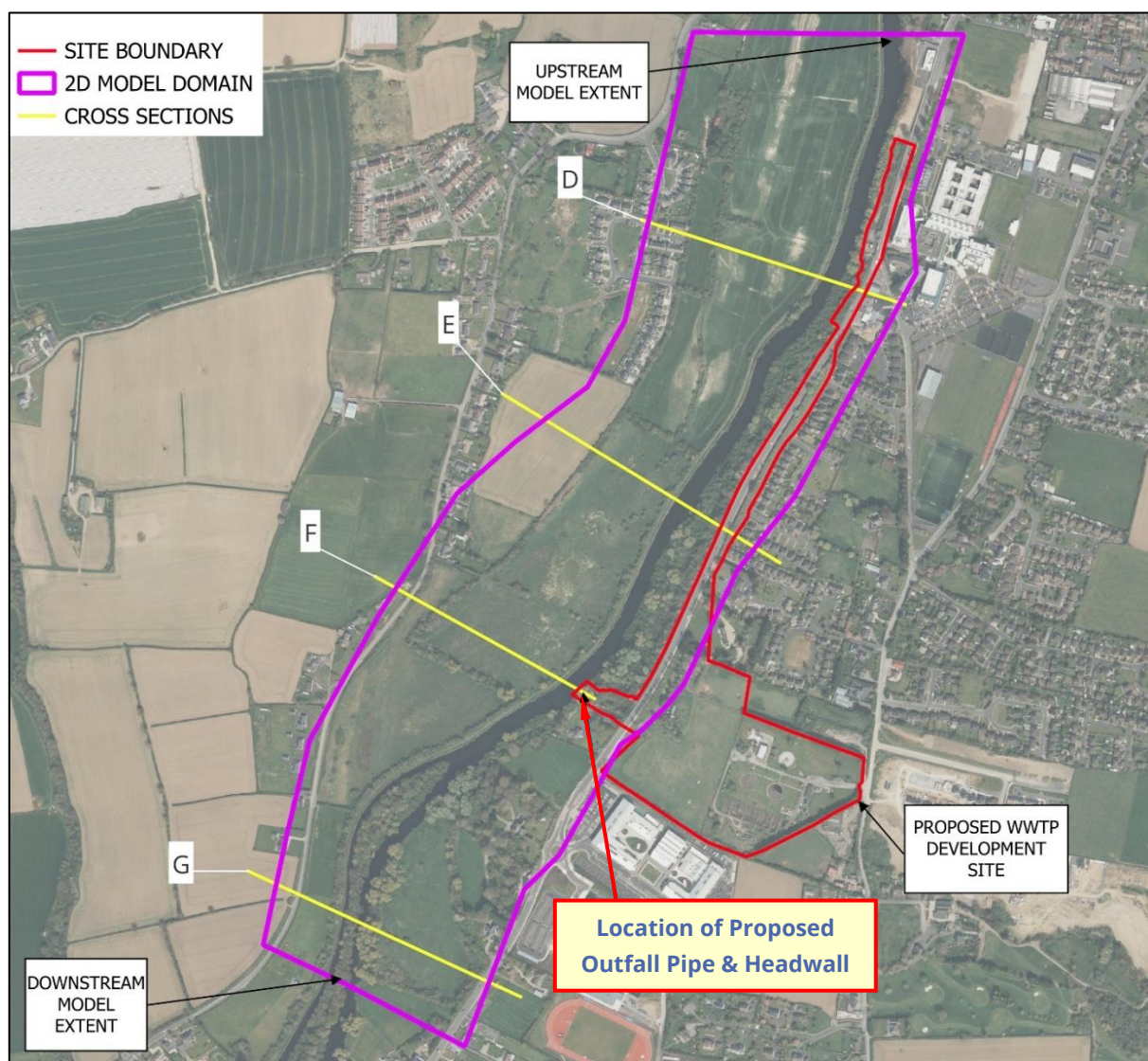
The delineated 5%ile and 50%ile fluvial extents illustrated in *Figure 14* above are also presented on *Drawing Number IE3120-002-A, Appendix A*.

The delineated 5%ile +CC and 50%ile + CC fluvial extents illustrated in *Figure 15* above are also presented on *Drawing Number IE3120-003-A, Appendix A*.



### 6.1.2. Flood Flows

The full extent of the 2D model domain was utilised for the flood flow hydraulic model simulation analysis. The 2D model domain utilised for the flood flow model simulation is illustrated below in *Figure 16*.



**Figure 16 – Hydraulic Model Cross Section Locations**

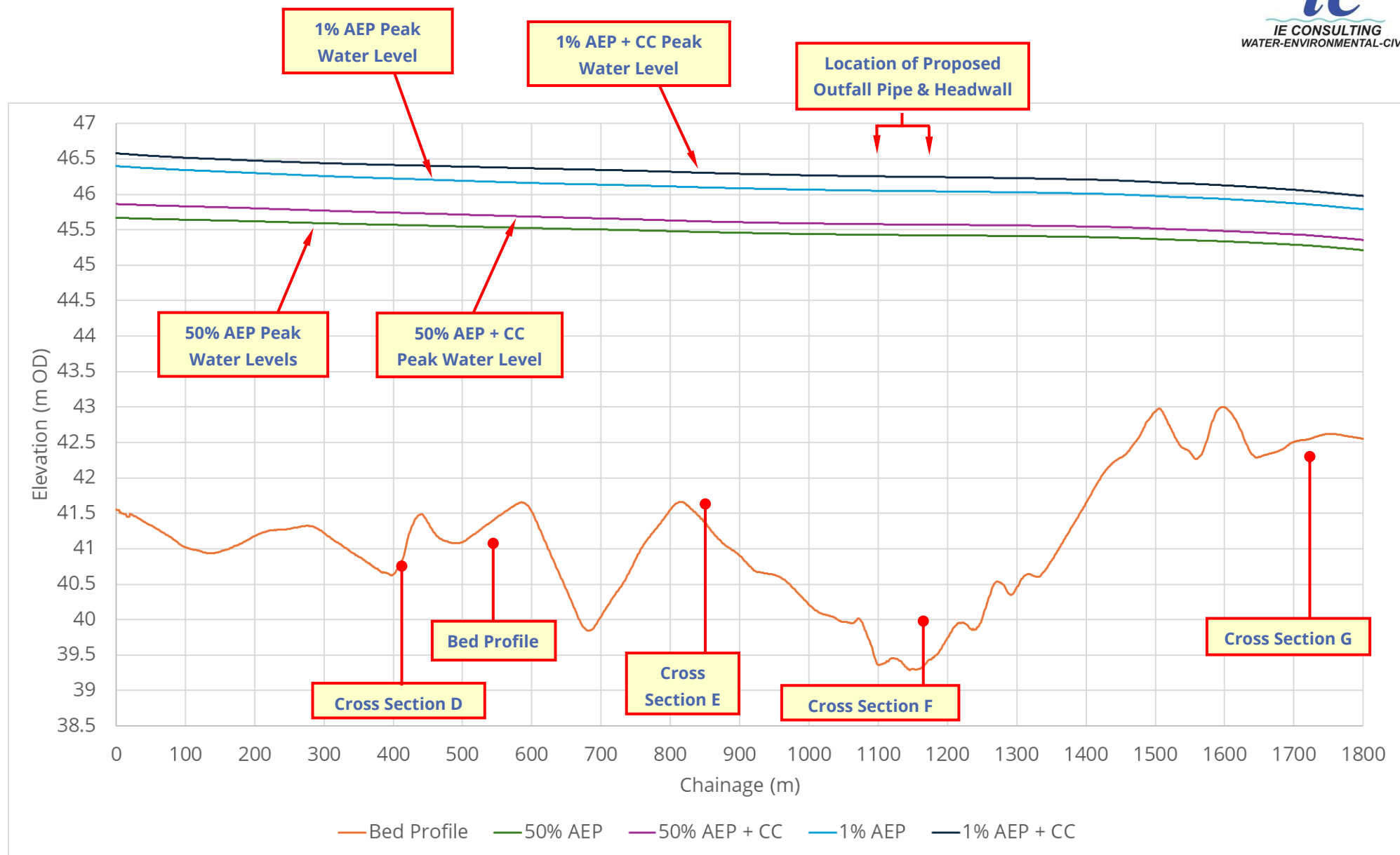
As illustrated in *Figure 16* above, four model cross sections are utilised in order to quantify modelled flood flow water levels and flow velocities at and in the vicinity of the proposed outfall pipe and headwall – i.e. Cross Section 'D' – upstream of proposed outfall pipe and headwall, Cross Section 'E' – upstream of proposed outfall pipe and headwall, Cross Section 'F' – at location of proposed outfall pipe and headwall, Cross Section 'G' – downstream of proposed outfall pipe and headwall.

Table 18 below lists the predictive Existing Baseline Scenario 50% AEP (1 in 2 year), 50% AEP+CC (1 in 2 year + climate change), 1% AEP (1 in 100 year) and 1% AEP+CC (1 in 100 year + climate change) fluvial flood levels at Cross Section 'D', Cross Section 'E', Cross Section 'F' and Cross Section 'G' as outputted by the hydraulic simulation model.

| Cross Section Label | 50% AEP Peak Flood Level (m OD) | 50% AEP + CC Peak Flood Level (m OD) | 1% AEP Peak Flood Level (m OD) | 1% AEP + CC Peak Flood Level (m OD) |
|---------------------|---------------------------------|--------------------------------------|--------------------------------|-------------------------------------|
| D                   | 45.57                           | 45.74                                | 46.223                         | 46.414                              |
| E                   | 45.47                           | 45.62                                | 46.102                         | 46.309                              |
| F                   | 45.42                           | 45.57                                | 46.043                         | 46.245                              |
| G                   | 45.29                           | 45.44                                | 45.876                         | 46.068                              |

**Table 18 – Predictive 50% AEP, 50% AEP + CC, 1% AEP & 1% AEP+CC Peak Flood Levels – Existing Baseline Scenario**

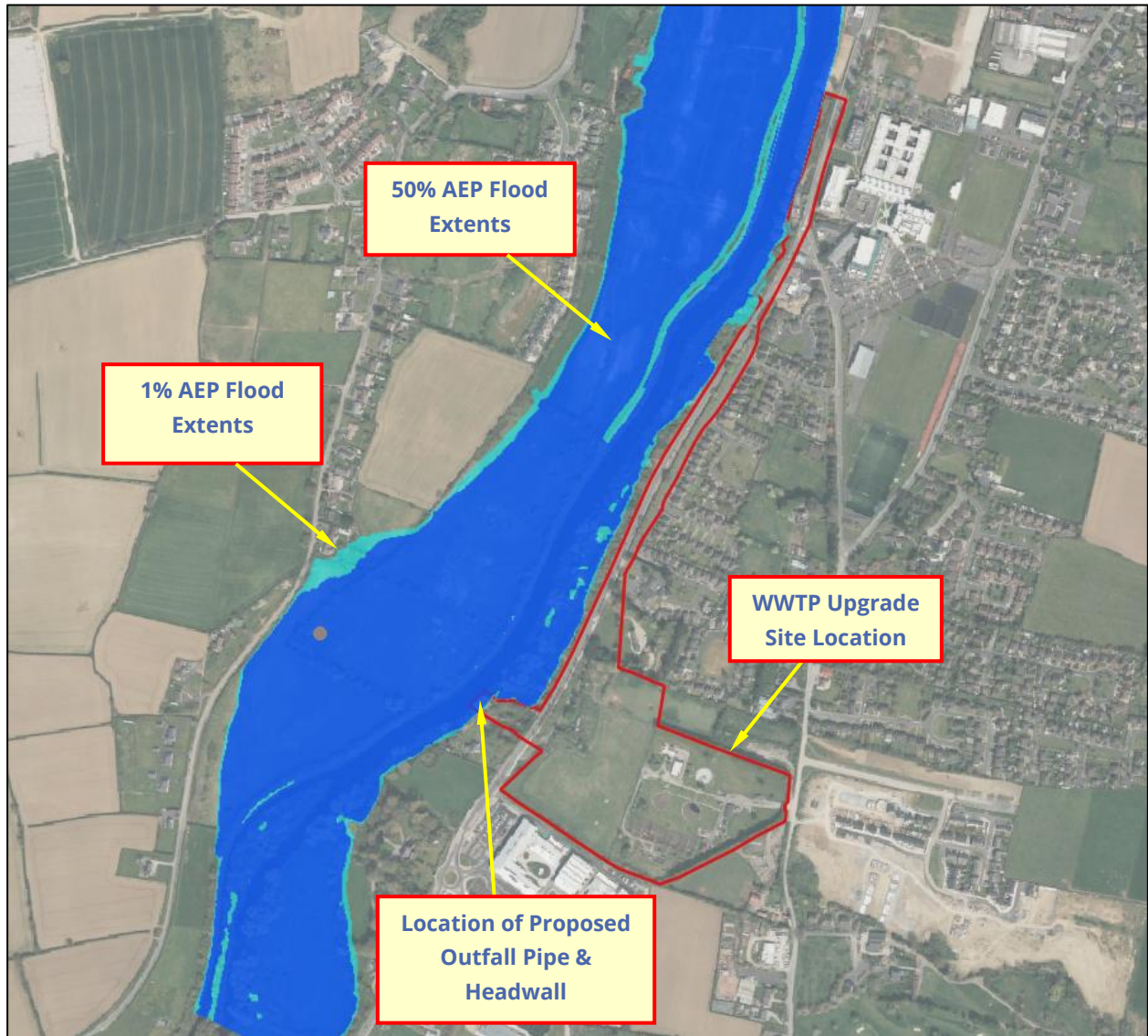
Figure 17 below illustrates the longitudinal hydraulic model profile of the predictive Existing Baseline Scenario 50% AEP (1 in 2 Year), 50% AEP + CC (1 in 2 year + climate change), 1% AEP (1 in 100 year) and 1% AEP + CC (1 in 100 year + climate change) flood levels along the modelled reach of River Barrow.



**Figure 17 – River Barrow – Longitudinal Hydraulic Profile – Existing Baseline Scenario**



The 50% AEP (1 in 2 year) and 1% AEP (1 in 100 year) fluvial flood extents in consideration of the Existing Baseline Scenario as outputted by the hydraulic simulation model are illustrated in *Figure 18* below.

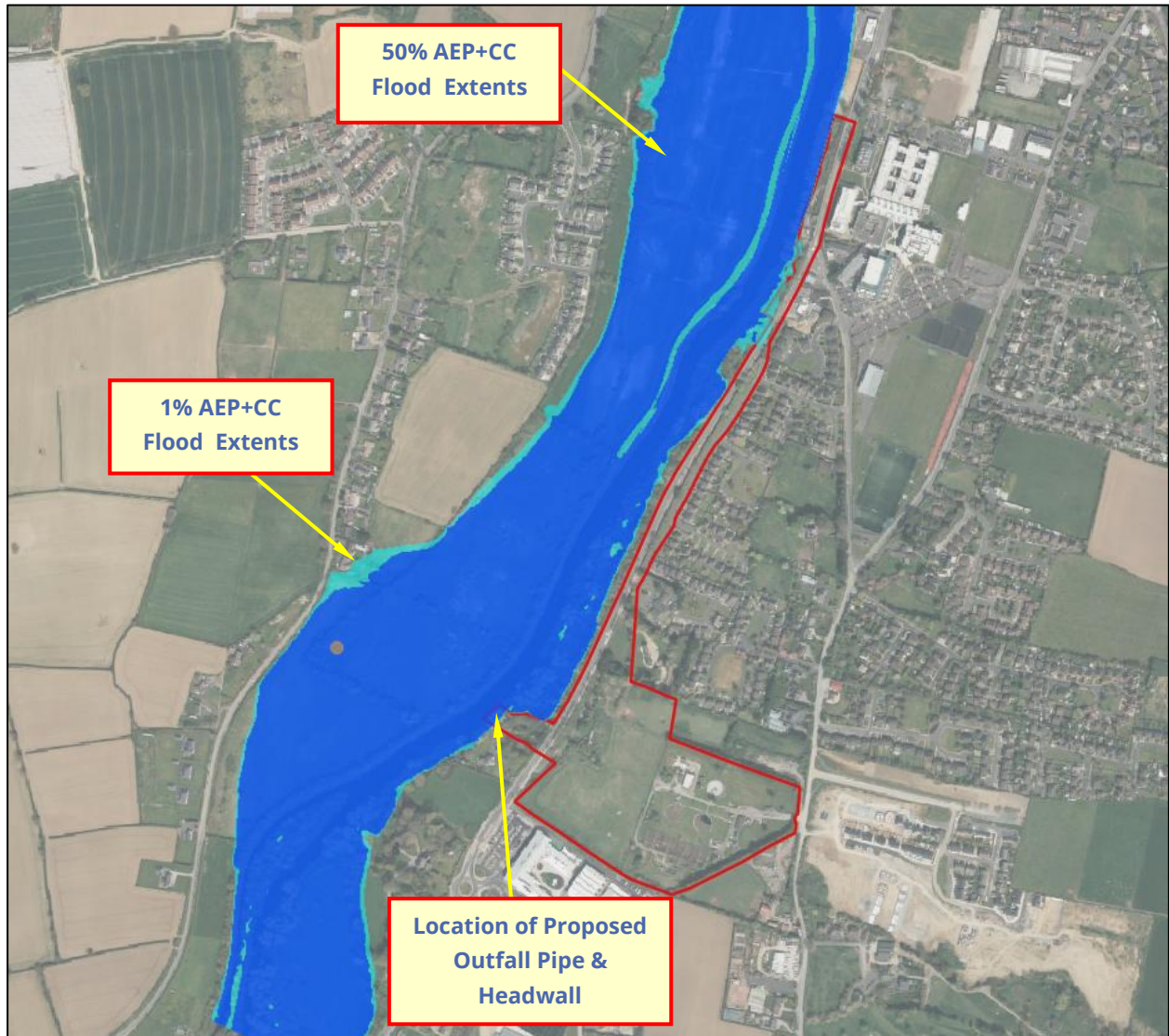


**Figure 18 - 50% AEP & 1% AEP Fluvial Flood Extents – Existing Baseline Scenario**

The delineated 50% AEP (1 in 2 year) and 1% AEP (1 in 100 year) fluvial flood extents illustrated in *Figure 18* above are also presented on *Drawing Number IE3120-004-A, Appendix A*.

As illustrated in *Figure 18* above, during the occurrence of a 50% AEP (1 in 2 year) and a 1% AEP (1 in 100 year) fluvial flood event, flood waters are predicted to overtop the right and left overbanks of the River Barrow, and within the location of the propose outfall pipe and headwall.

The 50% AEP + CC (1 in 2 year + climate change) and 1% AEP + CC (1 in 100 year + climate change) fluvial flood extents in consideration of the Existing Baseline Scenario as outputted by the hydraulic simulation model are illustrated in *Figure 19* below.



**Figure 19 - 50% AEP + CC & 1% AEP + CC Fluvial Flood Extents – Existing Baseline Scenario**

The delineated 50% AEP + CC (1 in 2 year + climate change) and 1% AEP + CC (1 in 100 year + climate change) fluvial flood extents illustrated in Figure 19 above are also presented on *Drawing Number IE3120-005-A, Appendix A*.

As illustrated in *Figure 19* above, during the occurrence of a 50% AEP + CC (1 in 2 year + climate change) and a 1% AEP + CC (1 in 100 year + climate change) fluvial flood event, flood waters are predicted to overtop the right and left overbanks of the River Barrow, and within the location of the propose outfall pipe and headwall.



## 6.2. Operation Stage Scenario

The assessment and analysis presented below considers the Operation Stage Scenario – i.e. the proposed outfall pipe and associated headwall works are complete, and no further construction works are undertaken at this location.

The assessment and analysis has been undertaken in consideration of the Low Flow and Flood Flow regime in the River Barrow at this location, and provides a comparative analysis in order to determine and quantify the impact, if any, that the proposed outfall pipe and headwall in the Operation Stage Scenario may have on the existing hydrodynamic and hydrological regime of the River Barrow at this location in comparison to the Existing Baseline Scenario presented in *Section 6.1* above.

### 6.2.1. Low Flows

As illustrated in *Figure 20* below, the proposed outfall pipe shall be constructed below ground to the location of the proposed outfall pipe headwall. The headwall will generally be of insitu concrete or precast concrete form of construction with wingwalls and of approximate dimensions of 1.65m high x 2.175m.



**Figure 20 - Proposed Outfall**

The Existing Baseline Scenario hydraulic simulation model was therefore updated and in order to include the line, level, location and geometric profile of the proposed outfall pipe and associated headwall structure as illustrated in *Figure 20* above, and the results were analysed and evaluated.

*Table 19* below lists the predictive Existing Baseline Scenario versus the Operation Stage Scenario 5%ile, 5%ile + CC, 50%ile and 50%ile + CC peak fluvial water levels at Cross Section 'A', Cross Section 'B' and Cross Section 'C' as outputted by the hydraulic simulation model.

*Table 20* below lists the predictive Existing Baseline Scenario versus the Operation Stage Scenario 5%ile, 5%ile + CC, 50%ile and 50%ile + CC peak flow velocities at Cross Section 'A', Cross Section 'B' and Cross Section 'C' as outputted by the hydraulic simulation model.

| Cross Section Label | 5%ile Peak Water Level (m OD)<br>Baseline Scenario | 5%ile + CC Peak Water Level (m OD)<br>Baseline Scenario | 50%ile Peak Water Level (m OD)<br>Baseline Scenario | 50%ile + CC Peak Water Level (m OD)<br>Baseline Scenario | 5%ile Peak Water Level (m OD)<br>Operation Stage Scenario | 5%ile + CC Peak Water Level (m OD)<br>Operation Stage Scenario | 50%ile Peak Water Level (m OD)<br>Operation Stage Scenario | 50%ile + CC Peak Water Level (m OD)<br>Operation Stage Scenario | 5%ile Peak Water Level (m)<br>Difference | 5%ile + CC Peak Water Level (m)<br>Difference | 50%ile Peak Water Level (m)<br>Difference | 50%ile + CC Peak Water Level (m)<br>Difference |
|---------------------|----------------------------------------------------|---------------------------------------------------------|-----------------------------------------------------|----------------------------------------------------------|-----------------------------------------------------------|----------------------------------------------------------------|------------------------------------------------------------|-----------------------------------------------------------------|------------------------------------------|-----------------------------------------------|-------------------------------------------|------------------------------------------------|
| A                   | 43.47                                              | 43.74                                                   | 41.87                                               | 42.00                                                    | 43.47                                                     | 43.74                                                          | 41.87                                                      | 42.00                                                           | 0                                        | 0                                             | 0                                         | 0                                              |
| B                   | 43.46                                              | 43.73                                                   | 41.86                                               | 41.99                                                    | 43.46                                                     | 43.73                                                          | 41.86                                                      | 41.99                                                           | 0                                        | 0                                             | 0                                         | 0                                              |
| C                   | 43.36                                              | 43.63                                                   | 41.79                                               | 41.92                                                    | 43.36                                                     | 43.63                                                          | 41.79                                                      | 41.92                                                           | 0                                        | 0                                             | 0                                         | 0                                              |

**Table 19 - Predictive 50%ile, 50%ile+ CC, 5%ile & 5%ile + CC Fluvial Water Levels – Existing Baseline Scenario vs Operation Stage Scenario**

| Cross Section Label | 5%ile Peak Flood Velocity (m/s)<br>Baseline Scenario | 5%ile + CC Peak Velocity (m/s)<br>Baseline Scenario | 50%ile Peak Velocity (m/s)<br>Baseline Scenario | 50%ile + CC Peak Velocity (m/s)<br>Baseline Scenario | 5%ile Peak Flood Velocity (m/s)<br>Operation Stage Scenario | 5%ile + CC Peak Velocity (m/s)<br>Operation Stage Scenario | 50%ile Peak Velocity (m/s)<br>Operation Stage Scenario | 50%ile + CC Peak Velocity (m/s)<br>Operation Stage Scenario | 5%ile Peak Flood Velocity (m/s)<br>Difference | 5%ile + CC Peak Velocity (m/s)<br>Difference | 50%ile Peak Velocity (m/s)<br>Difference | 50%ile + CC Peak Velocity (m/s)<br>Difference |
|---------------------|------------------------------------------------------|-----------------------------------------------------|-------------------------------------------------|------------------------------------------------------|-------------------------------------------------------------|------------------------------------------------------------|--------------------------------------------------------|-------------------------------------------------------------|-----------------------------------------------|----------------------------------------------|------------------------------------------|-----------------------------------------------|
| A                   | 1.632                                                | 1.735                                               | 0.956                                           | 1.039                                                | 1.632                                                       | 1.735                                                      | 0.956                                                  | 1.039                                                       | 0                                             | 0                                            | 0                                        | 0                                             |
| B                   | 1.549                                                | 1.647                                               | 0.634                                           | 0.733                                                | 1.549                                                       | 1.647                                                      | 0.634                                                  | 0.733                                                       | 0                                             | 0                                            | 0                                        | 0                                             |
| C                   | 1.679                                                | 1.780                                               | 0.918                                           | 1.001                                                | 1.679                                                       | 1.780                                                      | 0.918                                                  | 1.001                                                       | 0                                             | 0                                            | 0                                        | 0                                             |

**Table 20 - Predictive 50%ile, 50%ile+ CC, 5%ile, and 5%ile + CC Peak Velocities – Existing Baseline Scenario vs Operation Stage Scenario**

As presented in *Table 19 and Table 20* above, the results of the hydraulic simulation and analysis indicates that, in the Operation Stage Scenario, the proposed outfall pipe and associated headwall are not predicted to result in an increase in peak fluvial water levels or peak flow velocities in comparison to the Existing Baseline Scenario.

#### 6.2.2. Flood Flows

The Existing Baseline Scenario hydraulic simulation model was updated and in order to include the line, level, location and geometric profile of the proposed outfall pipe and associated headwall structure as illustrated in *Figure 20* above, and the results were analysed and evaluated.

*Table 21* below lists the predictive Existing Baseline Scenario versus the Operation Stage Scenario 50% AEP (1 in 2 year), 50% AEP + CC (1 in 2 year + climate change), 1% AEP (1 in 100 year) and 1% AEP + CC (1 in 100 year + climate change) peak fluvial flood levels at Cross Section 'D', Cross Section 'E', Cross Section 'F' and Cross Section 'G' as outputted by the hydraulic simulation model.

| Cross<br>Section<br>Label | 50% AEP<br>Peak<br>Flood<br>Level<br>(m OD)<br><br>Baseline<br>Scenario | 50% AEP<br>+ CC<br>Peak<br>Flood<br>Level<br>(m OD)<br><br>Baseline<br>Scenario | 1% AEP<br>Peak<br>Flood<br>Level<br>(m OD)<br><br>Baseline<br>Scenario | 1% AEP<br>+ CC<br>Peak<br>Flood<br>Level<br>(m OD)<br><br>Baseline<br>Scenario | 50% AEP<br>Peak<br>Flood<br>Level (m<br>OD)<br>Operation<br>Stage<br>Scenario | 50% AEP +<br>CC Peak<br>Flood<br>Level (m<br>OD)<br>Operation<br>Stage<br>Scenario | 1% AEP<br>Peak<br>Flood<br>Level (m<br>OD)<br>Operation<br>Stage<br>Scenario | 1% AEP +<br>CC Peak<br>Flood<br>Level (m<br>OD)<br>Operation<br>Stage<br>Scenario | 50% AEP<br>Peak<br>Flood<br>Level (m)<br><br>Difference | 50% AEP +<br>CC Peak<br>Flood<br>Level (m)<br><br>Difference | 1% AEP<br>Peak<br>Flood<br>Level (m)<br><br>Difference | 1% AEP +<br>CC Peak<br>Flood<br>Level (m)<br><br>Difference |
|---------------------------|-------------------------------------------------------------------------|---------------------------------------------------------------------------------|------------------------------------------------------------------------|--------------------------------------------------------------------------------|-------------------------------------------------------------------------------|------------------------------------------------------------------------------------|------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|---------------------------------------------------------|--------------------------------------------------------------|--------------------------------------------------------|-------------------------------------------------------------|
| D                         | 45.57                                                                   | 45.74                                                                           | 46.223                                                                 | 46.414                                                                         | 45.57                                                                         | 45.74                                                                              | 46.223                                                                       | 46.414                                                                            | 0                                                       | 0                                                            | 0                                                      | 0                                                           |
| E                         | 45.47                                                                   | 45.62                                                                           | 46.102                                                                 | 46.309                                                                         | 45.47                                                                         | 45.62                                                                              | 46.102                                                                       | 46.309                                                                            | 0                                                       | 0                                                            | 0                                                      | 0                                                           |
| F                         | 45.42                                                                   | 45.57                                                                           | 46.043                                                                 | 46.245                                                                         | 45.42                                                                         | 45.57                                                                              | 46.043                                                                       | 46.245                                                                            | 0                                                       | 0                                                            | 0                                                      | 0                                                           |
| G                         | 45.29                                                                   | 45.44                                                                           | 45.876                                                                 | 46.068                                                                         | 45.29                                                                         | 45.44                                                                              | 45.876                                                                       | 46.068                                                                            | 0                                                       | 0                                                            | 0                                                      | 0                                                           |

**Table 21 – Predictive 50% AEP, 50%AEP + CC, 1% AEP & 1% AEP + CC Flood Levels – Existing Baseline Scenario vs Operation Stage Scenario**



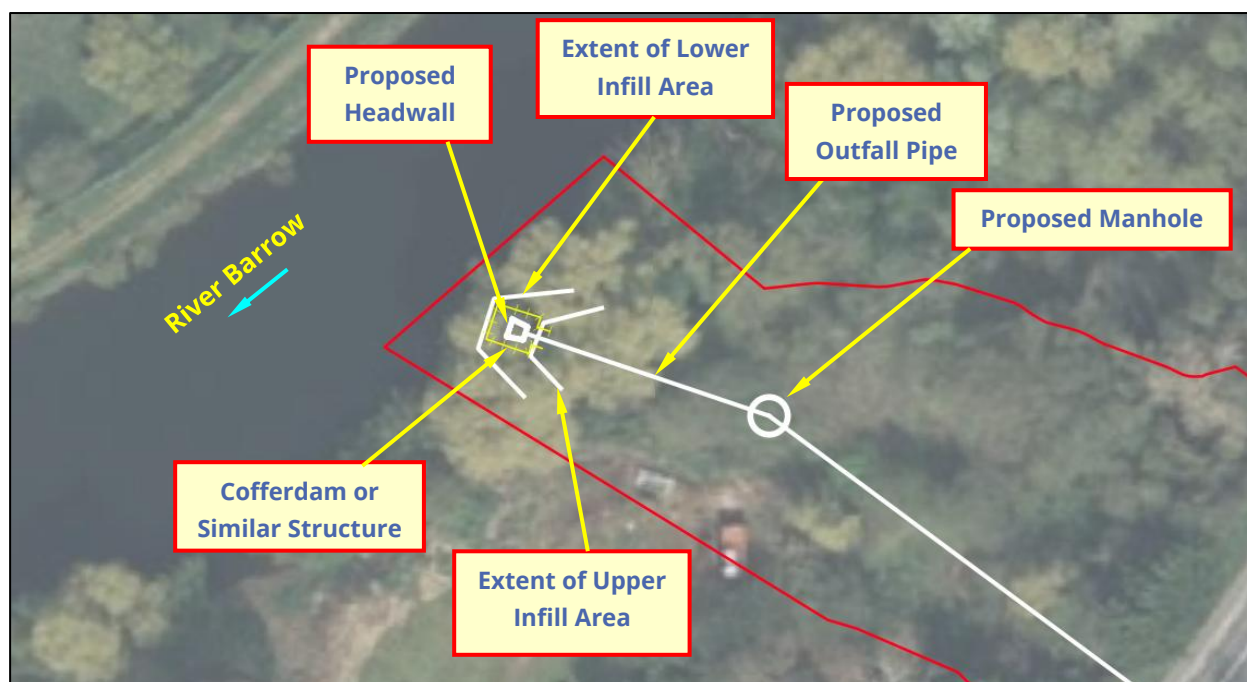
As presented in *Table 21* above, the results of the hydraulic simulation and analysis indicates that, in the Operation Stage Scenario, the proposed outfall pipe and associated headwall are not predicted to result in an increase in peak fluvial flood level water levels in comparison to the Existing Baseline Scenario.

### 6.3. Construction Stage Scenario

The assessment and analysis presented below considered the Construction Stage Scenario – i.e. a temporary cofferdam or similar structure will be provided in order to construct the outfall pipe and associated headwall within the area of the left overbank of the River Barrow watercourse. The impounding structure will have a width of 4m and a length of 5m.

The assessment and analysis has been undertaken in consideration of the Low Flow regime only in the River Barrow at this location, and provides a comparative analysis in order to determine and quantify the impact, if any, that the proposed outfall pipe and headwall in the Construction Stage Scenario may have on the existing hydrodynamic and hydrological regime of the River Barrow at this location in comparison to the Existing Baseline Scenario presented in *Section 5.1* above. Flood flows have not been considered for the Construction Stage Scenario as it is envisage that no works are expected to progress in the event of an extreme weather event (I.e. Flood Flows).

As illustrated in *Figure 21* below, in order to facilitate the construction of the proposed outfall pipe and associated headwall, a temporary lower infill area and upper infill area will be formed in order to allow access to this location for construction traffic and equipment. Within this infill area a temporary cofferdam or similar structure will be provided in order allow construction of the outfall pipe and associated headwall at this location.



**Figure 21 - Construction Stage**

The Existing Baseline Scenario hydraulic simulation model was therefore updated in order to include the line, level, location and geometric profile proposed temporary lower and upper infill areas and the proposed temporary cofferdam or similar structure.

*Table 22* below lists the predictive Existing Baseline Scenario versus the Construction Stage Scenario 5%ile, 5%ile + CC, 50%ile and 50%ile + CC peak fluvial water levels at Cross Section 'A', Cross Section 'B' and Cross Section 'C' as outputted by the hydraulic simulation model.

*Table 23* below lists the predictive Existing Baseline Scenario versus the Construction Stage Scenario 5%ile, 5%ile + CC, 50%ile and 50%ile + CC peak flow velocities at Cross Section 'A', Cross Section 'B' and Cross Section 'C' as outputted by the hydraulic simulation model.

| Cross Section Label | 5%ile Peak Water Level (m OD)<br>Baseline Scenario | 5%ile + CC Peak Water Level (m OD)<br>Baseline Scenario | 50%ile Peak Water Level (m OD)<br>Baseline Scenario | 50%ile + CC Peak Water Level (m OD)<br>Baseline Scenario | 5%ile Peak Water Level (m OD)<br>Construction Stage Scenario | 5%ile + CC Peak Water Level (m OD)<br>Construction Stage Scenario | 50%ile Peak Water Level (m OD)<br>Construction Stage Scenario | 50%ile + CC Peak Water Level (m OD)<br>Construction Stage Scenario | 5%ile Peak Water Level (m)<br>Difference | 5%ile + CC Peak Water Level (m)<br>Difference | 50%ile Peak Water Level (m)<br>Difference | 50%ile + CC Peak Water Level (m)<br>Difference |
|---------------------|----------------------------------------------------|---------------------------------------------------------|-----------------------------------------------------|----------------------------------------------------------|--------------------------------------------------------------|-------------------------------------------------------------------|---------------------------------------------------------------|--------------------------------------------------------------------|------------------------------------------|-----------------------------------------------|-------------------------------------------|------------------------------------------------|
| A                   | 43.47                                              | 43.74                                                   | 41.87                                               | 42.00                                                    | 43.47                                                        | 43.75                                                             | 41.87                                                         | 42.00                                                              | 0                                        | +0.01                                         | 0                                         | 0                                              |
| B                   | 43.46                                              | 43.73                                                   | 41.86                                               | 41.99                                                    | 43.46                                                        | 43.73                                                             | 41.86                                                         | 41.99                                                              | 0                                        | 0                                             | 0                                         | 0                                              |
| C                   | 43.36                                              | 43.63                                                   | 41.79                                               | 41.92                                                    | 43.36                                                        | 43.63                                                             | 41.79                                                         | 41.92                                                              | 0                                        | 0                                             | 0                                         | 0                                              |

**Table 22 - Predictive 5%ile, 5%ile+ CC, 50%ile & 50%ile + CC Fluvial Water Levels – Existing Baseline Scenario vs Construction Stage Scenario**

| Cross Section Label | 5%ile Peak Flood Velocity (m/s)<br>Baseline Scenario | 5%ile + CC Peak Velocity (m/s)<br>Baseline Scenario | 50%ile Peak Velocity (m/s)<br>Baseline Scenario | 50%ile + CC Peak Velocity (m/s)<br>Baseline Scenario | 5%ile Peak Flood Velocity (m/s)<br>Construction Stage Scenario | 5%ile + CC Peak Velocity (m/s)<br>Construction Stage Scenario | 50%ile Peak Velocity (m/s)<br>Construction Stage Scenario | 50%ile + CC Peak Velocity (m/s)<br>Construction Stage Scenario | 5%ile Peak Flood Velocity (m/s)<br>Difference | 5%ile + CC Peak Velocity (m/s)<br>Difference | 50%ile Peak Velocity (m/s)<br>Difference | 50%ile + CC Peak Velocity (m/s)<br>Difference |
|---------------------|------------------------------------------------------|-----------------------------------------------------|-------------------------------------------------|------------------------------------------------------|----------------------------------------------------------------|---------------------------------------------------------------|-----------------------------------------------------------|----------------------------------------------------------------|-----------------------------------------------|----------------------------------------------|------------------------------------------|-----------------------------------------------|
| A                   | 1.632                                                | 1.735                                               | 0.956                                           | 1.039                                                | 1.632                                                          | 1.735                                                         | 0.956                                                     | 1.039                                                          | 0                                             | 0                                            | 0                                        | 0                                             |
| B                   | 1.549                                                | 1.647                                               | 0.634                                           | 0.733                                                | 1.583                                                          | 1.677                                                         | 0.634                                                     | 0.733                                                          | +0.034                                        | +0.03                                        | 0                                        | 0                                             |
| C                   | 1.679                                                | 1.780                                               | 0.918                                           | 1.001                                                | 1.679                                                          | 1.780                                                         | 0.918                                                     | 1.001                                                          | 0                                             | 0                                            | 0                                        | 0                                             |

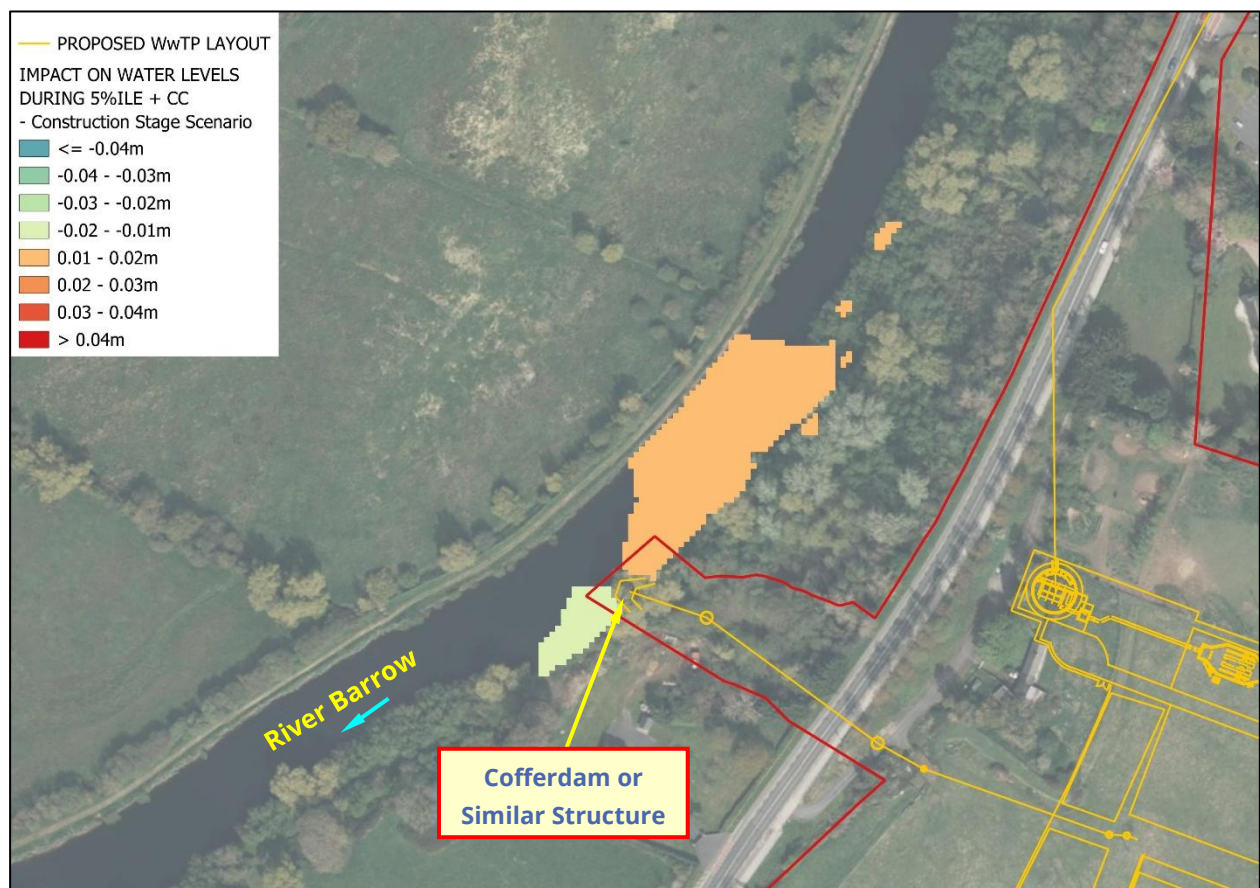
**Table 23 - Predictive 5%ile, 5%ile+ CC, 50% ile, and 50% ile + CC Peak Velocities – Existing Baseline Scenario vs Construction Stage Scenario**

As presented in *Table 22* and *Table 23* above, the results of the hydraulic simulation and analysis indicates that, in the Construction Stage Scenario, the proposed temporary lower and upper infill areas and the proposed temporary cofferdam or similar structure are for the majority not predicted to result in an increase in peak fluvial water level or peak flow velocities in comparison to the Existing Baseline Scenario.

As listed in *Table 22* above a small minor increase of 0.01m is predicted at the location of Cross Section 'A' in consideration of the 5%ile + CC event.

As listed in *Table 23* above a small minor increase of 0.034 m/s and 0.03 m/s is predicted at the location of Cross Section 'B' in consideration of the and 5%ile and the 5%ile + CC event respectively.

The potential small minor increase of 0.01m in water levels in consideration of the 5%ile + CC event is illustrated graphically in *Figure 22* below.



**Figure 22 - 5%ile + CC Event - Construction Stage Scenario Water Levels**

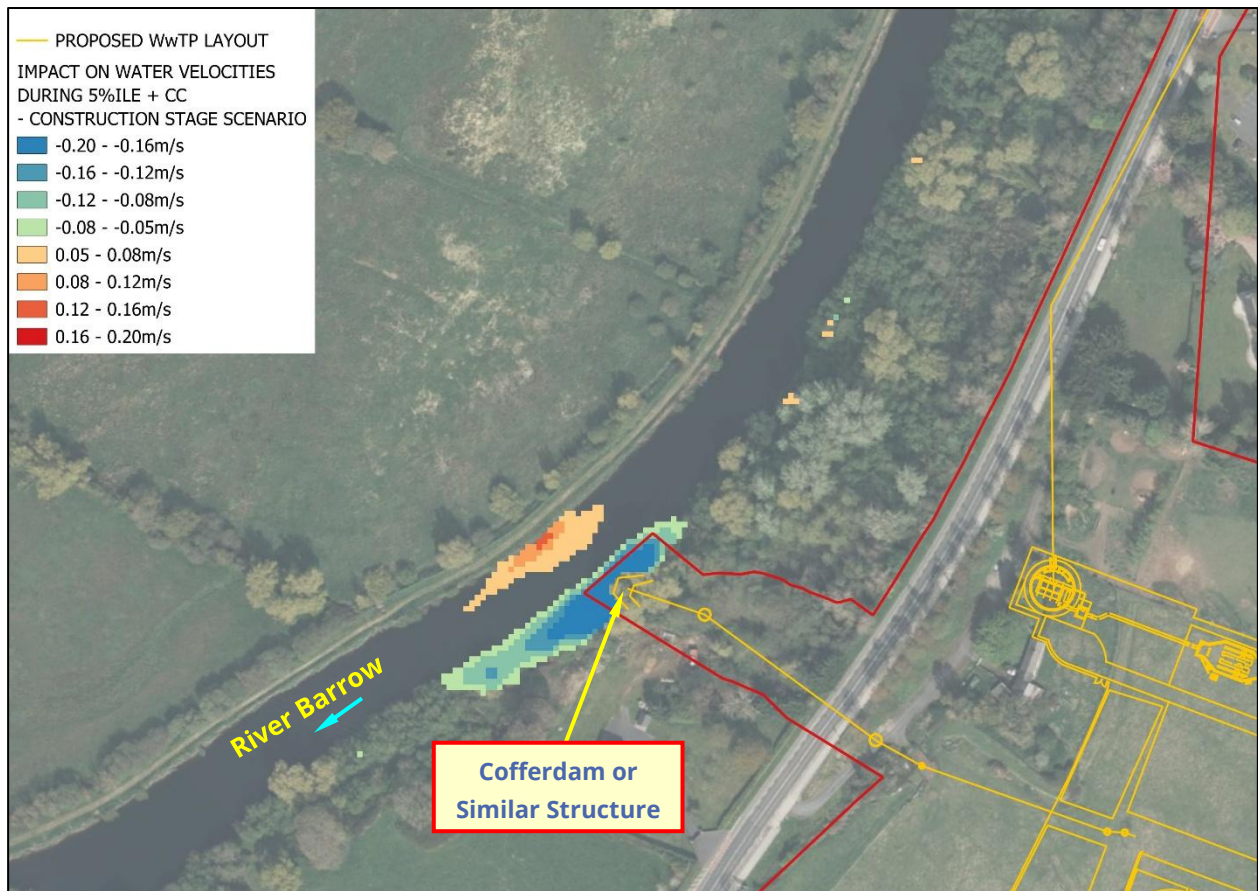
As illustrated in *Figure 22* above, in consideration of the 5%ile + CC event, a limited minor increase in water levels of the order of 0.01m is predicted immediately upstream of the proposed temporary cofferdam or similar structure for a distance of approximately 100m upstream, after which predictive water levels return to Existing Baseline Scenario levels. This potential small minor increase in water level is contained within the main watercourse channel of the River Barrow and does not encroach within adjacent left or right overbank lands.

A minor decrease in water levels is predicted immediately downstream of the proposed temporary cofferdam or similar structure for a distance of approximately 40m downstream, after which predictive water levels return to Existing Baseline Scenario levels.

Changes in water level mapping for the 5%ile, 5%ile+ CC, 50%ile, and 50%ile + CC are presented in *Appendix D*.



The potential small minor increase of 0.03 m/s in flow velocities in consideration of the 5%ile + CC event is illustrated graphically in *Figure 23* below.



**Figure 23 - 5%ile + CC Event - Construction Stage Scenario Flow Velocities**

As illustrated in *Figure 23* above, in consideration of the 5%ile + CC event, a minor limited increase in flow velocities of the order of 0.03 m/s is predicted at the location of the proposed temporary cofferdam or similar structure, and primarily adjacent to a limited reach length adjacent to the right overbank of the River Barrow.

A minor limited decrease in flow velocities of the order of 0.1 m/s is predicted at the location of the proposed temporary cofferdam or similar structure, and primarily adjacent to the limited reach length adjacent to the left overbank of the River Barrow.

Predictive flow velocities return to Existing Baseline Scenario levels approximately 40m upstream and approximately 70m downstream of the location of the proposed cofferdam or similar structure.

Change in water velocity mapping for the 50%ile, 50%ile+ CC, 5%ile, and 5%ile + CC are presented in *Appendix E*.

## 7. Discussion

The 2D hydraulic modelling and analysis undertaken as part of this assessment indicates that in consideration of the Construction Stage Scenario and the Operation Stage Scenario, the proposed outfall pipe and associated headwall are not predicted result in an adverse impact to Existing Baseline Scenario water levels or flow velocities, and in this regard the proposed outfall pipe and associated headwall will not alter or adversely impact existing patterns of erosion, accretion, sediment transport or deposition along this reach length of the River Barrow watercourse.

This conclusion is supported by the following key factors:

- 1) The sediment survey conducted within the river channel revealed minimal sediment deposition in the area. This is primarily due to the relatively straight alignment of the river at the location of the proposed outfall pipe and associated headwall, with no significant watercourse meanders or change of direction at, or upstream or downstream of this location. The gradient of the River Barrow watercourse channel is also significantly shallow at this location, and no existing significant hydraulic structures such as weir or bridge structures are present at this location. In such conditions, and where river energy and flow velocities remain consistent, significant sediment transport and deposition is unlikely to occur. As the river topography at this location is stable and flow velocities remain unchanged, erosion, accretion, sediment transport or deposition is not predicted to occur along this reach length of the River Barrow watercourse.
- 2) The proposed outfall pipe and associated headwall will be located on the left overbank of the River Barrow, and at a location where there is a significant existing vegetative cover. This vegetative cover provides a significant erosion potential buffer. Additionally, the Mortarstown WwTP - Outfall Temporary Works and Constructability technical note - (Document Number -5161805DG0444) specifies that "Sediment and erosion control measures shall be in place at and around the embankment to mitigate negative impacts of run-off from the site into the watercourse." There is no evidence of any erosion or accretion potential at this location and mitigation measures will be implemented during the Construction Stage Scenario in order to ensure that there is no adverse impact to the Existing Baseline Scenario.

- 3) In consideration of the Construction Stage Scenario, a minor limited increase in water levels and flow velocities is predicted as a result of the temporary cofferdam or similar structure, however these minor limited increase in water levels and flow velocities are strictly limited to the immediate area of the temporary cofferdam or similar structure and will not result in an increase of erosion, accretion or sediment transport or deposition potential at this location. The cofferdam dam or similar structure will be a temporary structure only, and will be in place only for the duration of the construction stage works.

In consideration of the above, the proposed outfall pipe and associated headwall will not result in an adverse impact to the existing hydrodynamic and hydrological regime of the River Barrow Watercourse at this location during the Construction Stage Scenario or the Operation Stage Scenario.

It is recommended that the proposed cofferdam or similar structure should be constructed to a minimum crest level of 46.25m OD, which is 2.52m above the 5%ile + CC water level and is 0.68m above the 50% AEP + CC (1 in 2 Year + climate change) flood level.

Short term rainfall data should be acquired from MET Eireann each day before construction within the River Barrow commences. The weather should be checked by a designated person every two hours while the work is ongoing. If a significant rainfall event is forecast in the River Barrow catchment area which could result in a flood event, the works within the River Barrow should be postponed.

An automated system which records river water levels immediately upstream of the proposed WwTP outfall shall be installed before construction works begin in the River Barrow. The system should be capable of sounding a loud and clear warning once water levels within the River Barrow reach a level of 44.42m OD. The 44.42m OD water level is 1m below the peak 50% AEP (1 in 2 Year) fluvial flood event in the River Barrow and is 1.83m below the top of the recommended sheet piling level. The automated system should be checked and serviced regularly by a competent person to ensure it is calibrated and working correctly.

The contractor should determine what level of exceedance they deemed to be acceptable. It is important to consider the amount of time needed to remove the equipment located within the channel if a flood event requires the works to be abandoned. The flows applied to determine the temporary barrier height have been estimated using statistical methods. While these are the best methods available for the site at this time there is still a level of uncertainty attached to them.

## 8. Summary Conclusions and Recommendations

In consideration of the findings of this hydrodynamic analysis the following conclusions are made in respect of the proposed outfall pipe and associated headwall:

- A hydrodynamic assessment and analysis has been undertaken in order to assess and quantify the potential short term (Construction Stage Scenario) and long-term (Operation Stage Scenario) impact of the proposed new outfall pipe and associated headwall to the existing hydrodynamic and hydrological regime of the River Barrow watercourse at this location.
- Low flows in the River Barrow watercourse at this location were determined using the EPA's Low Flow Duration Curve (LFDC) Tool. Flows for the 5%ile and 50%ile scenarios were calculated for this assessment.
- Flood flows in the River Barrow were estimated using the 7 – Variable QMED Equation and applying the same growth factors used in the OPW South Eastern CFRAMS Hydrology Report.
- A 2D hydraulic simulation model was developed in HEC-RAS in order to provide a quantitative comparative analysis of the three phases of the proposed outfall pipe and associated headwall, these being the Existing Baseline Scenario, the Construction Stage Scenario and the Operational Stage Scenario.
- The 2D hydraulic modelling and analysis undertaken as part of this assessment indicates that in consideration of the Construction Stage Scenario and the Operation Stage Scenario, the proposed outfall pipe and associated headwall are not predicted result in an adverse impact to Existing Baseline Scenario water levels or flow velocities.
- In this regard the proposed outfall pipe and associated headwall will not alter or adversely impact existing patterns of erosion, accretion, sediment transport or deposition along this reach length of the River Barrow watercourse.
- It is recommended that the sheet piling be built to a level of 46.25m OD which is 2.52m above the 5%ile + CC and is 0.68m above the 50% AEP + CC (1 in 2 Year + climate change).
- The contractor shall ultimately determine what level of exceedance they deemed to be acceptable. It is important to consider the amount of time needed to remove the equipment located within the channel if a flood event requires the works to be abandoned.

- The flows used to determine these levels were derived using statistical methods. Local weather and flow conditions may require a change to the height of the structure.
- Short term rainfall data should be acquired from MET Eireann each day before construction within the River Barrow commences. The weather should be checked by a designated person every two hours while the work is ongoing. If a significant rainfall event is forecast in the River Barrow catchment area which could result in a flood event, the works within the River Barrow should be postponed.
- An automated system which records river water levels immediately upstream of the proposed WwTP outfall shall be installed before construction works begin in the River Barrow. The system should be capable of sounding a loud and clear warning once water levels within the River Barrow reach a level of 44.42m OD. The 44.42m OD water level is 1m below the peak 50% AEP (1 in 2 Year) fluvial flood event in the River Barrow and is 1.83m below the top of the recommended sheet piling level. The automated system should be checked and serviced regularly by a competent person to ensure it is calibrated and working correctly.
- The contractor should determine what level of exceedance they deemed to be acceptable. It is important to consider the amount of time needed to remove the equipment located within the channel if a flood event requires the works to be abandoned. The flows applied to determine the temporary barrier height have been estimated using statistical methods. While these are the best methods available for the site at this time there is still a level of uncertainty attached to them.
- While there may be localised impacts on water levels and velocities during the construction stage within the immediate vicinity of the proposed WwTP outfall when compared to the baseline, these become negligible once 100 metres upstream and downstream of the outfall.
- In summary, the hydrodynamic assessment and analysis presented in this study report indicates that the proposed outfall pipe and associated headwall will not result in an adverse impact to the existing hydrodynamic and hydrological regime of the River Barrow Watercourse at this location during the Construction Stage Scenario or the Operation Stage Scenario.



# Appendices

## Appendix A. Drawings

Drawing Number IE3120-001-A      Site Location Map

Drawing Number IE3120-002-A      5%ile & 50%ile Fluvial  
Extents – Baseline Scenario

Drawing Number IE3120-003-A      5%ile + CC & 50%ile + CC  
Fluvial Extents – Baseline Scenario

Drawing Number IE3120-004-A      50% AEP (1 in 2 Year) & 1%  
AEP (1 in 100 Year) Fluvial Flood Extents – Baseline Scenario

Drawing Number IE3120-005-A      50% AEP + CC (1 in 2 Year +  
Climate Change) & 1% AEP + CC (1 in 100 Year + Climate  
Change) Fluvial Flood Extents – Baseline Scenario





LEGEND

|      |          |           |     |     |
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| A    | 26.08.25 | ISSUE     | MOF | PMS |
| rev. | date     | amendment | drn | ckd |

PROPOSED MORTARSTOWN WWTW UPGRADE PROJECT, CARLOW

HYDRODYNAMIC ASSESSMENT

LOCATION MAP



CARLOW OFFICE:  
INNOVATION CENTRE  
GREEN ROAD  
CARLOW R95 W248

NEWRY OFFICE:  
1 RDC HOUSE  
WIN BUSINESS PARK  
NEWRY BT35 6PH

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|                 |                    | drawn:    | MOF      |                  |
| drawing no.     |                    | checked:  | PMS      |                  |
|                 |                    | approved: | PMS      |                  |
| IE3120-001      |                    | rev:      | A        | date: 26/08/2025 |

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LEGEND

- WWTP UPGRADE SITE LOCATION
- 5%ILE FLUVIAL EXTENTS
- 50%ILE FLUVIAL EXTENTS

|      |          |           |     |     |
|------|----------|-----------|-----|-----|
| A    | 26.08.25 | ISSUE     | MOF | PMS |
| rev. | date     | amendment | drn | ckd |

PROPOSED MORTARSTOWN WWTP UPGRADE PROJECT, CARLOW

HYDRODYNAMIC ASSESSMENT

5%ILE & 50%ILE FLUVIAL EXTENTS  
BASELINE SCENARIO



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CARLOW OFFICE:  
INNOVATION CENTRE  
GREEN ROAD  
CARLOW R95 W248

NEWRY OFFICE:  
1 RDC HOUSE  
WIN BUSINESS PARK  
NEWRY BT35 6PH

|                                   |  |                  |    |
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|                                   |  | date: 26/08/2025 |    |
|                                   |  | rev: A           |    |

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LEGEND

- WWTP UPGRADE SITE LOCATION
- 5%ILE + CC FLUVIAL EXTENTS
- 50%ILE + CC FLUVIAL EXTENTS

|      |          |           |     |     |
|------|----------|-----------|-----|-----|
| A    | 26.08.25 | ISSUE     | MOF | PMS |
| rev. | date     | amendment | drn | ckd |

PROPOSED MORTARSTOWN WWTP UPGRADE PROJECT, CARLOW

HYDRODYNAMIC ASSESSMENT

5%ILE + CC & 50%ILE + CC FLUVIAL EXTENTS BASELINE SCENARIO



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WATER-ENVIRONMENTAL-CIVIL

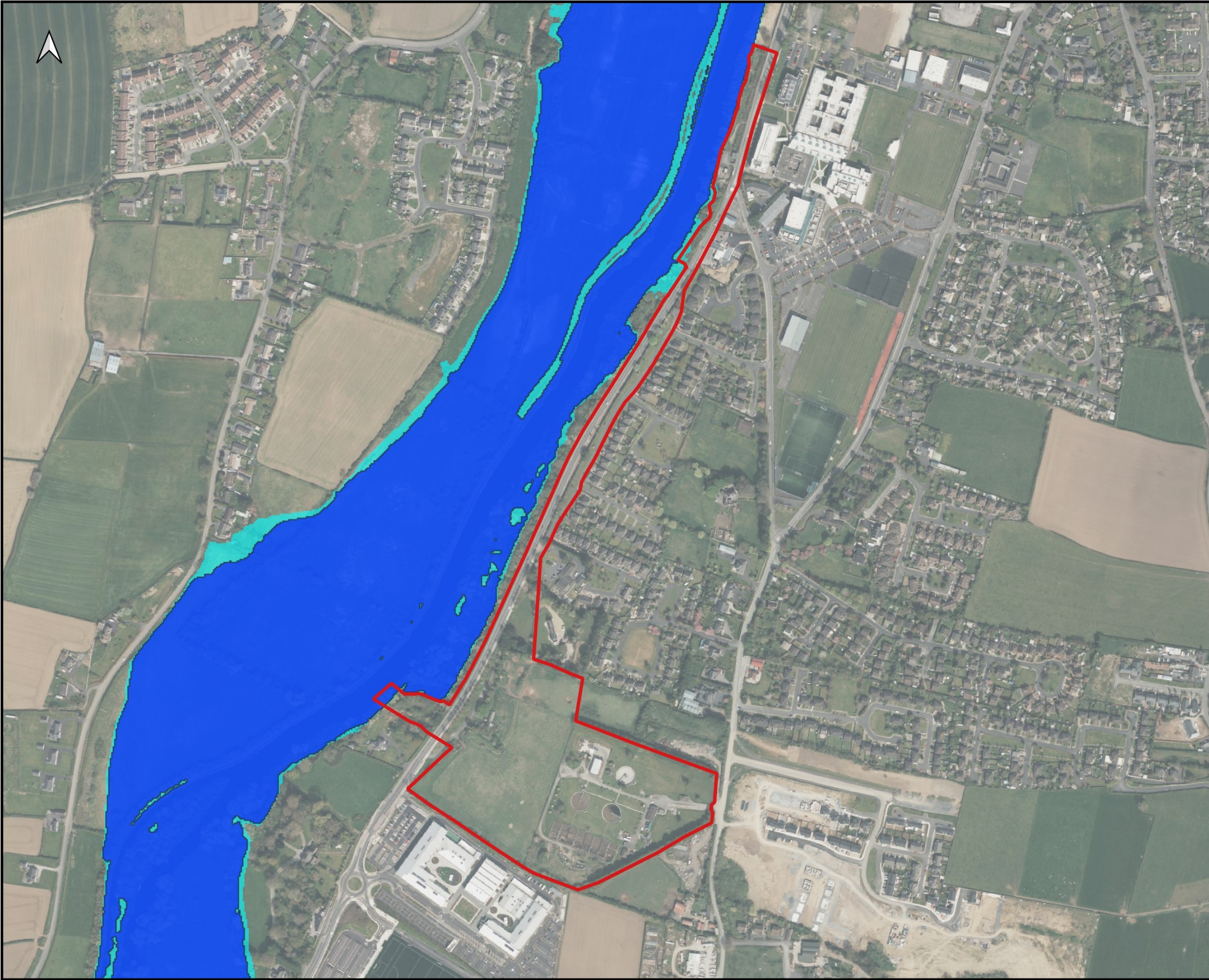
CARLOW OFFICE:  
INNOVATION CENTRE  
GREEN ROAD  
CARLOW R95 W248

NEWRY OFFICE:  
1 RDC HOUSE  
WIN BUSINESS PARK  
NEWRY BT35 6PH

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|                                   |  | date: 26/08/2025 |    |

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LEGEND

WWTP UPGRADE SITE LOCATION

50% AEP (1 IN 2 YEAR)  
FLUVIAL FLOOD EXTENTS

1% AEP (1 IN 100 YEAR)  
FLUVIAL FLOOD EXTENTS

|      |          |           |     |     |
|------|----------|-----------|-----|-----|
| A    | 26.08.25 | ISSUE     | MOF | PMS |
| rev. | date     | amendment | drn | ckd |

PROPOSED MORTARSTOWN WWTP UPGRADE  
PROJECT, CARLOW

HYDRODYNAMIC ASSESSMENT

50% AEP (1 IN 2 YEAR) & 1% AEP (1 IN 100  
YEAR) FLUVIAL EXTENTS  
BASELINE SCENARIO

  
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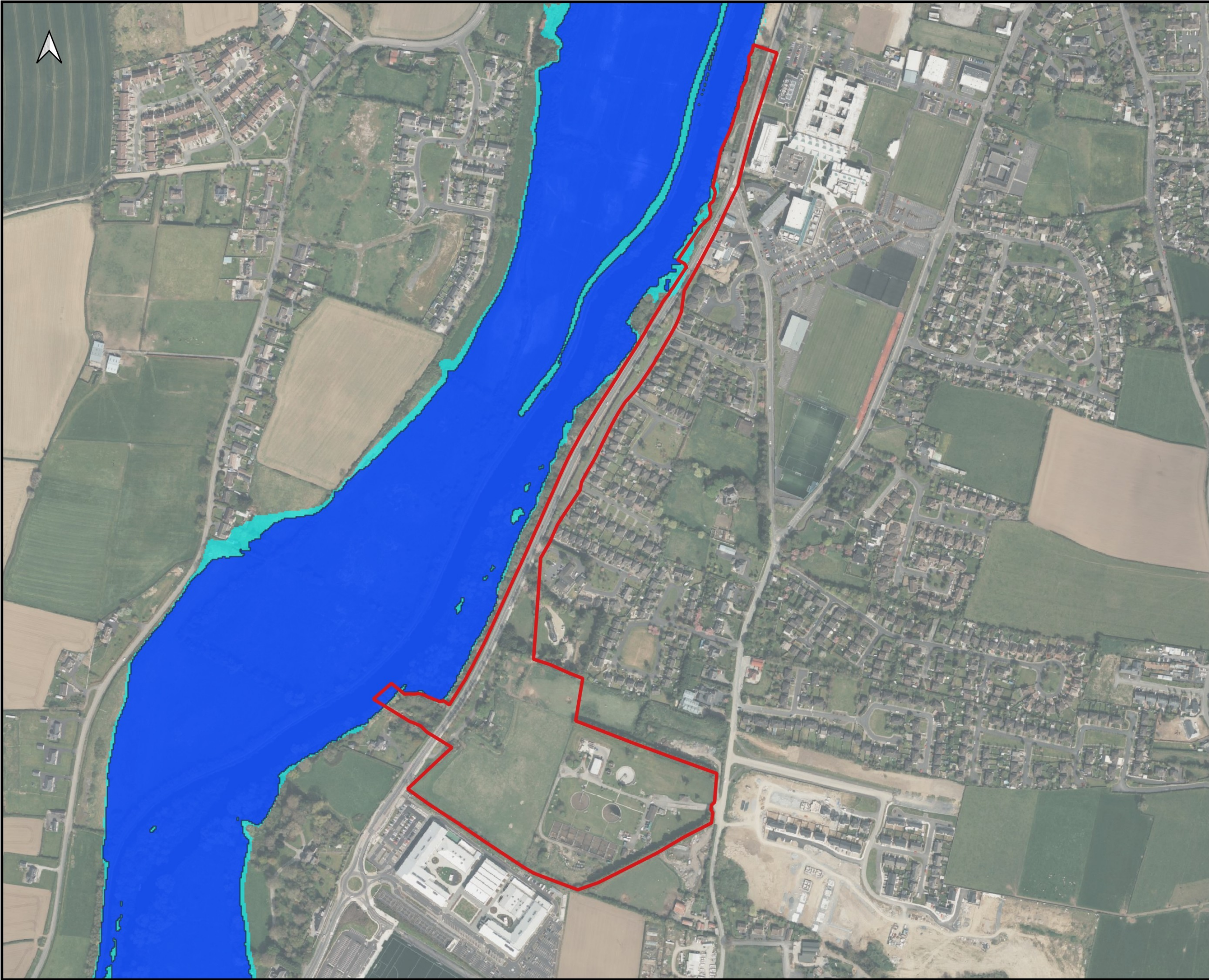
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INNOVATION CENTRE  
GREEN ROAD  
CARLOW R95 W248

NEWRY OFFICE:  
1 RDC HOUSE  
WIN BUSINESS PARK  
NEWRY BT35 6PH

|                                   |               |                  |    |
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|                                   |               | date: 26/08/2025 |    |

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LEGEND

- WWTP UPGRADE SITE LOCATION
- 50% AEP (1 IN 2 YEAR + CLIMATE CHANGE) FLUVIAL FLOOD EXTENTS
- 1% AEP (1 IN 100 YEAR + CLIMATE CHANGE) FLUVIAL FLOOD EXTENTS

|      |          |           |     |     |
|------|----------|-----------|-----|-----|
| A    | 26.08.25 | ISSUE     | MOF | PMS |
| rev. | date     | amendment | drn | ckd |

PROPOSED MORTARSTOWN WWTP UPGRADE PROJECT, CARLOW

HYDRODYNAMIC ASSESSMENT

50% AEP + CC (1 IN 2 YEAR + CLIMATE CHANGE) & 1% AEP + CC (1 IN 100 YEAR + CLIMATE CHANGE) FLUVIAL EXTENTS BASELINE SCENARIO



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WATER-ENVIRONMENTAL-CIVIL

CARLOW OFFICE:  
INNOVATION CENTRE  
GREEN ROAD  
CARLOW R95 W248

NEWRY OFFICE:  
1 RDC HOUSE  
WIN BUSINESS PARK  
NEWRY BT35 6PH

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|                                   |                | date: 26/08/2025 |

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## Appendix B. Particle Size Distribution

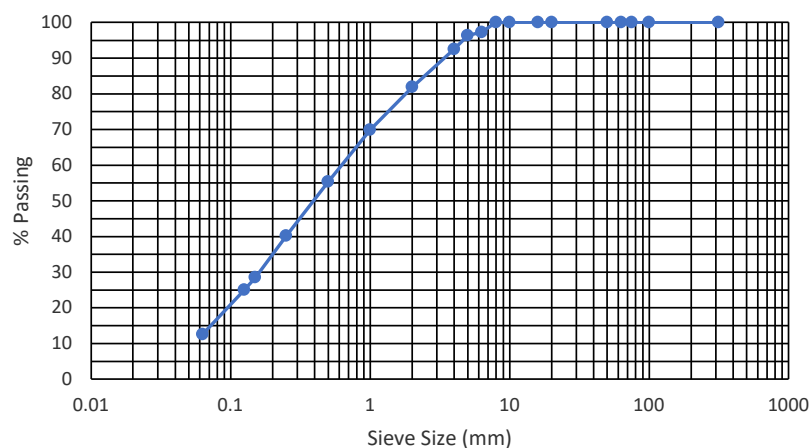
# Test Report

## Determination of Particle Size Distribution

Tested in accordance with BS EN ISO 17892-4:2016



**Report No.** R168713  
**Contract No.** 25974  
**Contract Name:** River sediment Samples  
**Client:** IECE  
**Lab Sample No.** A25/1812  
**Client Ref\*:** Sample 1  
**Material Type:** Soil  
**Sample Received:** 12/05/2025  
**Date test started:** 12/05/2025  
**Soil Description** Brown organic SILT/CLAY  
**Assumed Particle Density** 2.65Mg/m<sup>3</sup>



| Sieve Size | % Passing | Sieve Size | % Passing |
|------------|-----------|------------|-----------|
| 125        | 100       | 6.3        | 97        |
| 100        | 100       | 5          | 96        |
| 75         | 100       | 4          | 93        |
| 63         | 100       | 2          | 82        |
| 50         | 100       | 1          | 70        |
| 31.5       | 100       | 0.5        | 55        |
| 20         | 100       | 0.25       | 40        |
| 16         | 100       | 0.15       | 29        |
| 10         | 100       | 0.125      | 25        |
| 8          | 100       | 0.063      | 13        |

Results relate only to the specimen tested, in as received condition unless otherwise noted.

Opinions and interpretations are outside the scope of accreditation.

\* denotes Customer supplied information.

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### Persons authorised to approve report

J Barrett (Quality Manager)

H Byrne (Laboratory Manager)

IGSL Ltd Materials Laboratory

Approved by

*H Byrne*

Date

27/5/25

Page

1 of 1



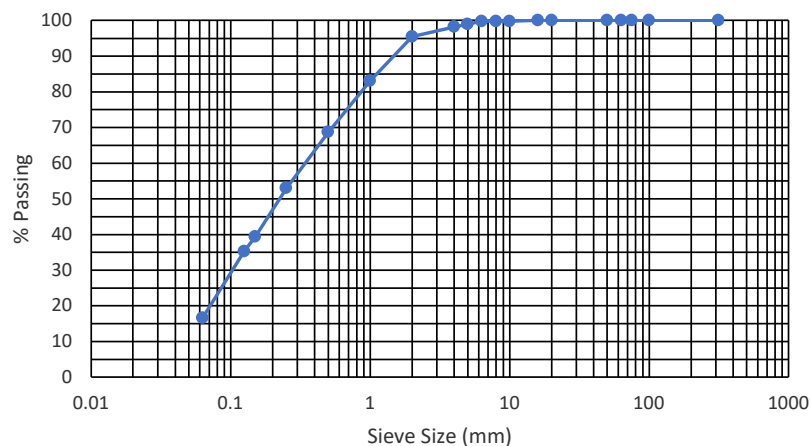
## Test Report

### Determination of Particle Size Distribution

Tested in accordance with BS EN ISO 17892-4:2016



**Report No.** R168714  
**Contract No.** 25974  
**Contract Name:** River sediment Samples  
**Client:** IECE  
**Lab Sample No.** A25/1813  
**Client Ref\*:** Sample 2  
**Material Type:** Soil  
**Sample Received:** 12/05/2025  
**Date test started:** 12/05/2025  
**Soil Description** Brown organic SILT/CLAY  
**Assumed Particle Density** 2.65Mg/m<sup>3</sup>



| Sieve Size | % Passing | Sieve Size | % Passing |
|------------|-----------|------------|-----------|
| 125        | 100       | 6.3        | 100       |
| 100        | 100       | 5          | 99        |
| 75         | 100       | 4          | 98        |
| 63         | 100       | 2          | 96        |
| 50         | 100       | 1          | 83        |
| 31.5       | 100       | 0.5        | 69        |
| 20         | 100       | 0.25       | 53        |
| 16         | 100       | 0.15       | 39        |
| 10         | 100       | 0.125      | 35        |
| 8          | 100       | 0.063      | 17        |

Results relate only to the specimen tested, in as received condition unless otherwise noted.

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J Barrett (Quality Manager)

H Byrne (Laboratory Manager)

IGSL Ltd Materials Laboratory

Approved by

*H Byrne*

Date

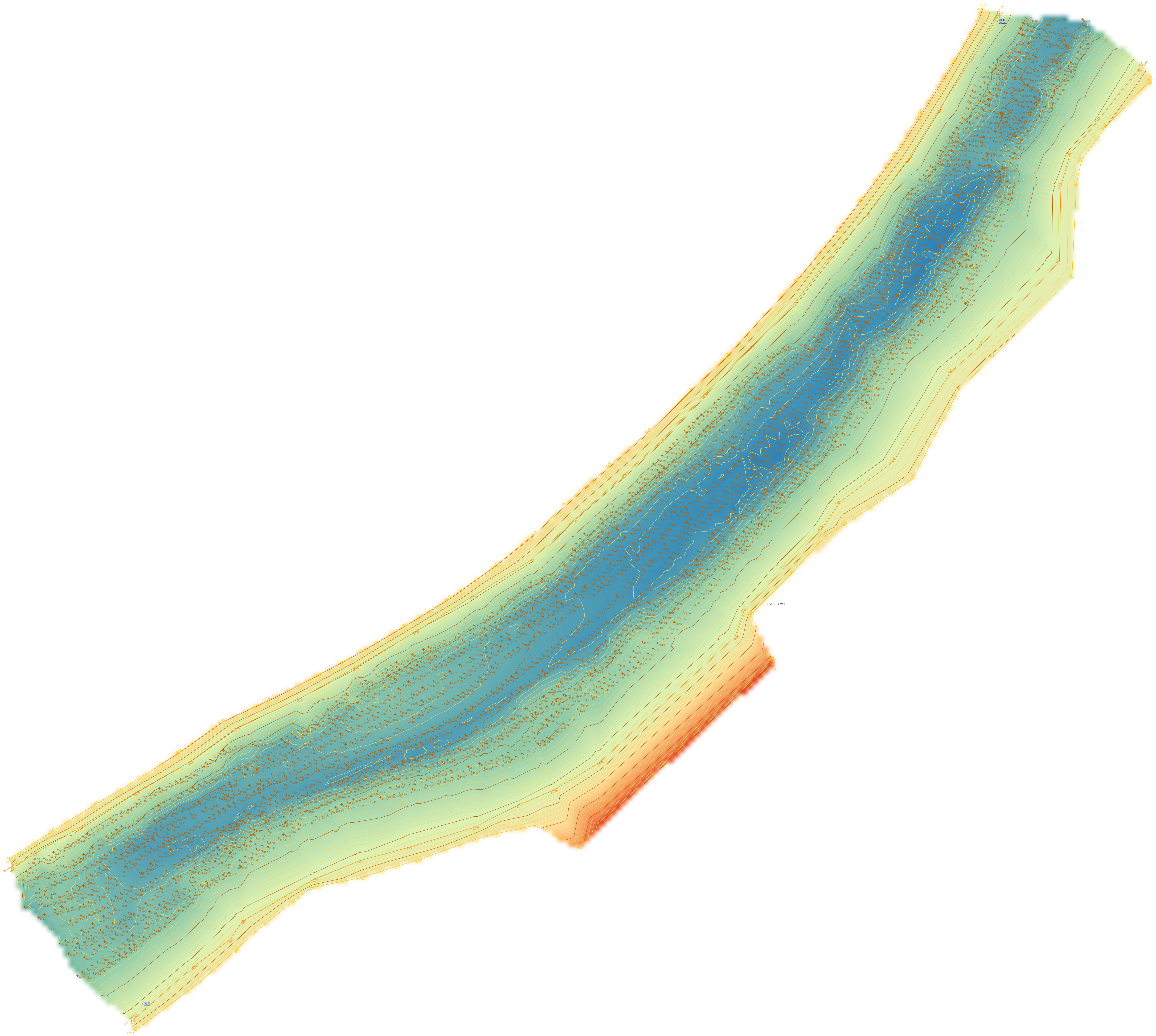
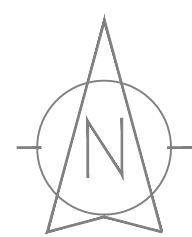
27/5/25

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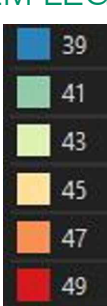
1 of 1

# Appendix C. River Barrow Topographic Survey





DEM LEGEND



### LEGEND

#### Street furniture & Services

- 5.12 Over Head Wire (LUAS) - Pylon ESB
- 5.12 Flowerbed
- 5.12 Pipe
- 5.12 Lift
- 5.12 Barrier
- 5.12 Pump
- 5.12 Bus/Tram Shelter
- 5.12 Postbox
- Valve - General
- Water Valve
- Gas Valve
- Sluice Valve
- Air Valve
- Street Cask
- C/P Post
- Marker Post
- Traffic Light
- Parking Meter
- Plane Aerial Mark
- Smart Card Validator
- Unknown Valve
- Bus Stop
- Bench Seat
- Kiosk
- Gully
- Coashole Cover
- Bore Hole
- Electricity Pole
- Telegraph pole
- OCS Pole
- CCTV Camera Pole
- Lamp Post
- Foul Manhole
- Surface Water MH
- Manholes
- Services Inspection Cover
- Traffic Inspection Cover
- Cable TV Inspection Cover
- ESAT Inspection Cover
- NTL Inspection Cover
- Ercom Inspection Cover
- Rodding Eye
- Phone Box
- Duct
- Gas Cover
- P P Box
- UG Gas Park Vent
- Waste Bin
- Hydrant
- Fire Hydrant
- ESB Box
- ESB Inspection Cover
- Traffic Control Box
- LUAS Technical Cubicle
- Ticket Vending Machine
- Water Meter Cover
- Telecom Inspection Cover
- Monument / Toilets
- Tank Storage
- Basement: MHL Cover & Pipe
- Dished Aerial Mark
- Stay for pole
- Pipe Protection
- Washout

#### Natural Features

- 5.12 Surface Change
- 5.12 Land Drain
- 5.12 Bottom of Slope
- 5.12 Top of Slope
- 5.12 Ditch
- 5.12 Water Edge / Lake / Pond
- Hedge / Trees Drip Line / Vegetation
- Tree Coniferous
- Tree Deciduous
- Top of Tree
- Water Level
- Cover Level
- Invert level
- Bed Level
- Spotheight
- Golf
- Fair Way
- Green
- Tee Box
- Other
- Survey Station
- Photo point

#### Built Features

##### Roads & Road Markings

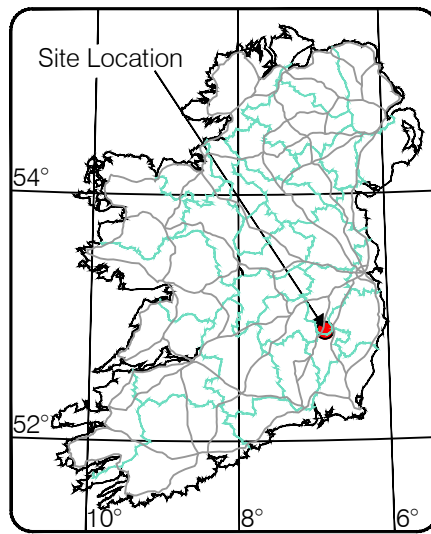
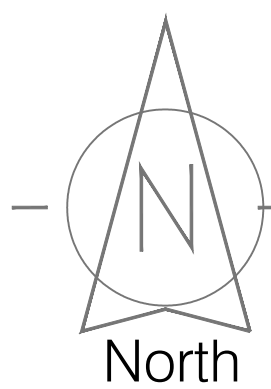
- 5.12 Building
- 5.12 Edge of Road
- 5.12 Kerb Bottom
- 5.12 Kerb Top
- 5.12 Bridge Abutment
- 5.12 Bridge Deck
- 5.12 Bridge Parapet
- 5.12 Building Facade
- 5.12 Footpath / Platform Tram & Tram
- 5.12 Damp Proof Course / Vene
- 5.12 Bridge Pier / Wall & Gate Pilar / LUAS Trackbed
- 5.12 Cycleway / Private Landing Area
- 5.12 Fence
- 5.12 Gate
- 5.12 Road Centreline
- 5.12 Top of Wall
- 5.12 Hoarding
- 5.12 Property Line
- 5.12 Road Scar
- 5.12 Top of Fence
- 5.12 Wall / Retaining Wall
- 5.12 Railway / Tram Rail / Gding / Ramp
- 5.12 Building Canopy / Roof / Overhang
- Floor Level
- Apex Height
- Eaves Height
- Parapet Height
- Soft Level
- Step Level
- Concrete Pad
- Track

#### Murphy Geospatial Ltd. Disclaimer

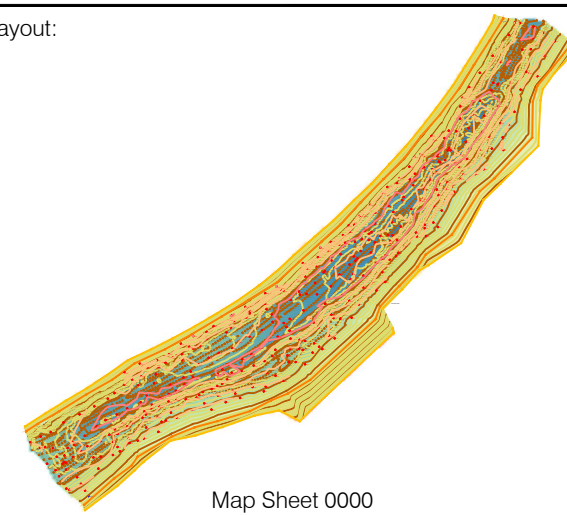
The user or recipient of this survey data understands and acknowledges this data may be inaccurate or contain errors or omissions and the user or recipient assumes full responsibility for any risks or damages resulting from, arising from, or in connection with any use of or reliance upon data displayed herein. Although significant care has been exercised to produce surveys that satisfy survey accuracy standards, these surveys are only as accurate as the source data from which they were compiled. Although all reasonable steps have been taken to locate all features visible at the time of the survey, there is no guarantee that all will be shown on the drawing, as some above ground features may have obstructed the survey. Wherever possible, areas unable to be surveyed will be labelled as 'UTS'.

The Company shall not be liable for any inaccuracy of the data provided beyond the specified scale or accuracy, or for any matters resulting from their use for purposes other than that stated in the Contract. No liability shall attach to the Surveyor in respect of any consequential loss or damages suffered by the Client.

The Client must promptly notify the Company of any errors in mapping of which it becomes aware. If misleading, inaccurate or otherwise inappropriate information is brought to the Company's attention or the Company itself identifies any such imprecision or error in a survey, it shall use its reasonable endeavours to fix or remove it and if necessary in certain instances, the Company being on notice of any such misleading, inaccurate or otherwise inappropriate information, it will re-conduct the survey and reproduce the data to within the specified scale or accuracy.



Map Sheet Layout:



|                   |                   |                                                                                      |
|-------------------|-------------------|--------------------------------------------------------------------------------------|
| Surveyed by : MGS | Date : May 2025   | Datum : Mean Hk 19                                                                   |
| Drawn by : CE     | Date : May 2025   | Grid System:                                                                         |
| Checked by : MR   | Date : 13.05.2025 | Irish National Grid <input type="checkbox"/> ITM <input checked="" type="checkbox"/> |
| Revisions         |                   |                                                                                      |
| No                | Date              | Description                                                                          |
| 1                 | 13.05.2025        | First Drawing                                                                        |
|                   |                   |                                                                                      |
|                   |                   |                                                                                      |
|                   |                   |                                                                                      |
|                   |                   |                                                                                      |



Topographic surveys, Measured Building Surveys,  
Setting-Out, As-Built Surveys, Hydrographic Surveys, Legal Mapping,  
Pipeline Surveys, Services Location, Ground Penetrating Radar,  
Laser Scanning, Aerial Photography

Kildare Cork Dublin Belfast Glasgow Manchester London

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Kilcullen Business Campus  
Kilcullen Co. Kildare, Ireland  
Phone: (+353) 045 484040  
Fax: (+353) 045 484004  
Email: info@murphygs.ie

|                                                                                |                            |
|--------------------------------------------------------------------------------|----------------------------|
| <b>Client :</b><br>IE Consulting Engineers                                     |                            |
| <b>Project :</b><br>63112 Bathymetric Survey and Soil Sampling of River Barrow |                            |
| <b>Date :</b><br>13.05.2025                                                    | <b>Scale :</b><br>1:250@A0 |
| <b>Description :</b><br>Topographical Survey                                   |                            |
| <b>Drawing Number :</b><br>MGS63112_Barrow_Bathy_01                            |                            |

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## Appendix D. Impact of Construction Stage on River Barrow Water Levels





LEGEND

- WWTP UPGRADE SITE LOCATION
- PROPOSED WWTP LAYOUT
- SHEET PILING

IMPACT ON WATER LEVELS  
DURING 5%ILE  
- CONSTRUCTION STAGE SCENARIO

- <= -0.04M
- 0.04 - -0.03M
- 0.03 - -0.02M
- 0.02 - -0.01M
- 0.01 - 0.02M
- 0.02 - 0.03M
- 0.03 - 0.04M
- > 0.04M

|      |          |           |     |     |
|------|----------|-----------|-----|-----|
| A    | 26.08.25 | ISSUE     | MOF | PMS |
| rev. | date     | amendment | drn | ckd |

PROPOSED MORTARSTOWN WWTP UPGRADE  
PROJECT, CARLOW

HYDRODYNAMIC ASSESSMENT

5%ILE CHANGE IN WATER LEVELS  
CONSTRUCTION STAGE SCENARIO



**IE CONSULTING**  
WATER-ENVIRONMENTAL-CIVIL

CARLOW OFFICE:  
INNOVATION CENTRE  
GREEN ROAD  
CARLOW R95 W248

NEWRY OFFICE:  
1 RDC HOUSE  
WIN BUSINESS PARK  
NEWRY BT35 6PH

|                                   |                |                  |
|-----------------------------------|----------------|------------------|
| file location: N:\IE3120\DRAWINGS | scale: 1:1,500 | A3               |
| drawing status: PLANNING          | datum: MALIN   |                  |
|                                   | drawn: MOF     |                  |
| drawing no. IE3120-100            | rev: A         | checked: PMS     |
|                                   |                | approved: PMS    |
|                                   |                | date: 26/08/2025 |

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LEGEND

- WWTP UPGRADE SITE LOCATION
- PROPOSED WWTP LAYOUT
- SHEET PILING

IMPACT ON WATER LEVELS  
DURING 5%ILE + CC  
- CONSTRUCTION STAGE SCENARIO

- $\leq -0.04\text{M}$
- $-0.04 - -0.03\text{M}$
- $-0.03 - -0.02\text{M}$
- $-0.02 - -0.01\text{M}$
- $0.01 - 0.02\text{M}$
- $0.02 - 0.03\text{M}$
- $0.03 - 0.04\text{M}$
- $> 0.04\text{M}$

|      |          |           |     |     |
|------|----------|-----------|-----|-----|
| A    | 26.08.25 | ISSUE     | MOF | PMS |
| rev. | date     | amendment | drn | ckd |

PROPOSED MORTARSTOWN WWTP UPGRADE  
PROJECT, CARLOW

HYDRODYNAMIC ASSESSMENT

5%ILE + CC CHANGE IN WATER LEVELS  
CONSTRUCTION STAGE SCENARIO



**IE CONSULTING**  
WATER-ENVIRONMENTAL-CIVIL

CARLOW OFFICE:  
INNOVATION CENTRE  
GREEN ROAD  
CARLOW R95 W248

NEWRY OFFICE:  
1 RDC HOUSE  
WIN BUSINESS PARK  
NEWRY BT35 6PH

|                                   |                |                  |
|-----------------------------------|----------------|------------------|
| file location: N:\IE3120\DRAWINGS | scale: 1:1,500 | A3               |
| drawing status: PLANNING          | datum: MALIN   |                  |
|                                   | drawn: MOF     |                  |
| drawing no. IE3120-101            | rev: A         | checked: PMS     |
|                                   |                | approved: PMS    |
|                                   |                | date: 26/08/2025 |

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LEGEND

- WWTP UPGRADE SITE LOCATION
- PROPOSED WWTP LAYOUT
- SHEET PILING

IMPACT ON WATER LEVELS  
DURING 50%ILE  
- CONSTRUCTION STAGE SCENARIO

- <= -0.04M
- 0.04 - -0.03M
- 0.03 - -0.02M
- 0.02 - -0.01M
- 0.01 - 0.00M
- 0.00 - 0.01M
- 0.01 - 0.02M
- 0.02 - 0.03M
- 0.03 - 0.04M
- > 0.04M

|      |          |           |     |     |
|------|----------|-----------|-----|-----|
| A    | 26.08.25 | ISSUE     | MOF | PMS |
| rev. | date     | amendment | drn | ckd |

PROPOSED MORTARSTOWN WWTP UPGRADE PROJECT, CARLOW

HYDRODYNAMIC ASSESSMENT

50%ILE CHANGE IN WATER LEVELS  
CONSTRUCTION STAGE SCENARIO



**IE CONSULTING**  
WATER-ENVIRONMENTAL-CIVIL

CARLOW OFFICE:  
INNOVATION CENTRE  
GREEN ROAD  
CARLOW R95 W248

NEWRY OFFICE:  
1 RDC HOUSE  
WIN BUSINESS PARK  
NEWRY BT35 6PH

|                                   |                |                  |
|-----------------------------------|----------------|------------------|
| file location: N:\IE3120\DRAWINGS | scale: 1:1,500 | A3               |
| drawing status: PLANNING          | datum: MALIN   |                  |
|                                   | drawn: MOF     |                  |
| drawing no. IE3120-102            | rev: A         | checked: PMS     |
|                                   |                | approved: PMS    |
|                                   |                | date: 26/08/2025 |

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NOTE: THERE IS NO IMPACT ON WATER LEVELS DURING THE CONSTRUCTION STAGE SCENARIO DURING THE 50% FLUVIAL EVENT





LEGEND

- WWTP UPGRADE SITE LOCATION
- PROPOSED WWTP LAYOUT
- SHEET PILING

IMPACT ON WATER LEVELS  
DURING 50%ILE + CC  
- CONSTRUCTION STAGE SCENARIO

- <= -0.04M
- 0.04 - -0.03M
- 0.03 - -0.02M
- 0.02 - -0.01M
- 0.01 - 0.02M
- 0.02 - 0.03M
- 0.03 - 0.04M
- > 0.04M

|      |          |           |     |     |
|------|----------|-----------|-----|-----|
| A    | 26.08.25 | ISSUE     | MOF | PMS |
| rev. | date     | amendment | drn | ckd |

PROPOSED MORTARSTOWN WWTP UPGRADE PROJECT, CARLOW

HYDRODYNAMIC ASSESSMENT

50%ILE + CC CHANGE IN WATER LEVELS  
CONSTRUCTION STAGE SCENARIO



**IE CONSULTING**  
WATER-ENVIRONMENTAL-CIVIL

CARLOW OFFICE:  
INNOVATION CENTRE  
GREEN ROAD  
CARLOW R95 W248

NEWRY OFFICE:  
1 RDC HOUSE  
WIN BUSINESS PARK  
NEWRY BT35 6PH

|                                   |                |                  |
|-----------------------------------|----------------|------------------|
| file location: N:\IE3120\DRAWINGS | scale: 1:1,500 | A3               |
| drawing status: PLANNING          | datum: MALIN   |                  |
|                                   | drawn: MOF     |                  |
| drawing no. IE3120-103            | rev: A         | checked: PMS     |
|                                   |                | approved: PMS    |
|                                   |                | date: 26/08/2025 |

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NOTE: THERE IS NO IMPACT ON WATER LEVELS DURING THE CONSTRUCTION STAGE SCENARIO DURING THE 50% + CC FLUVIAL EVENT



## Appendix E. Impact of Construction Stage on River Barrow Velocities



LEGEND

- WWTP UPGRADE SITE LOCATION
- PROPOSED WWTP LAYOUT
- SHEET PILING

|      |          |           |     |     |
|------|----------|-----------|-----|-----|
| A    | 26.08.25 | ISSUE     | MOF | PMS |
| rev. | date     | amendment | drn | ckd |

PROPOSED MORTARSTOWN WWTP UPGRADE  
PROJECT, CARLOW

HYDRODYNAMIC ASSESSMENT

5%ILE CHANGE IN WATER VELOCITIES  
CONSTRUCTION STAGE SCENARIO



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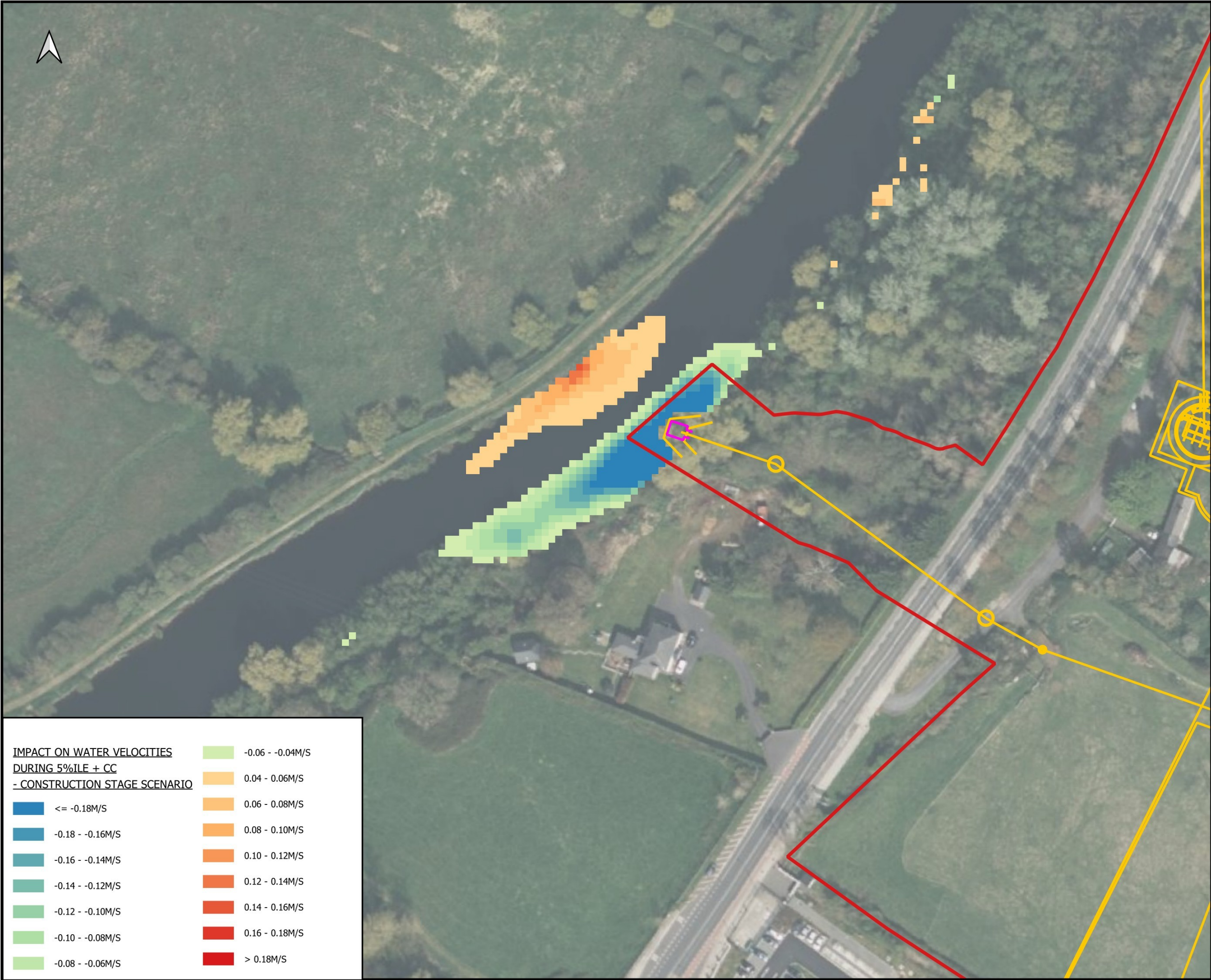
CARLOW OFFICE:  
INNOVATION CENTRE  
GREEN ROAD  
CARLOW R95 W248

NEWRY OFFICE:  
1 RDC HOUSE  
WIN BUSINESS PARK  
NEWRY BT35 6PH

|                                   |                |                  |
|-----------------------------------|----------------|------------------|
| file location: N:\IE3120\DRAWINGS | scale: 1:1,500 | A3               |
| drawing status: PLANNING          | datum: MALIN   |                  |
|                                   | drawn: MOF     |                  |
| drawing no. IE3120-200            | rev: A         | checked: PMS     |
|                                   |                | approved: PMS    |
|                                   |                | date: 26/08/2025 |

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LEGEND

- WWTP UPGRADE SITE LOCATION
- PROPOSED WWTP LAYOUT
- SHEET PILING

|      |          |           |     |     |
|------|----------|-----------|-----|-----|
| A    | 26.08.25 | ISSUE     | MOF | PMS |
| rev. | date     | amendment | drn | ckd |

PROPOSED MORTARSTOWN WWTP UPGRADE PROJECT, CARLOW

HYDRODYNAMIC ASSESSMENT

5%ILE + CC CHANGE IN WATER VELOCITIES CONSTRUCTION STAGE SCENARIO



IE CONSULTING  
WATER-ENVIRONMENTAL-CIVIL

CARLOW OFFICE:  
INNOVATION CENTRE  
GREEN ROAD  
CARLOW R95 W248

NEWRY OFFICE:  
1 RDC HOUSE  
WIN BUSINESS PARK  
NEWRY BT35 6PH

|                                   |                |                  |
|-----------------------------------|----------------|------------------|
| file location: N:\IE3120\DRAWINGS | scale: 1:1,500 | A3               |
| drawing status: PLANNING          | datum: MALIN   |                  |
|                                   | drawn: MOF     |                  |
| drawing no. IE3120-201            | rev: A         | checked: PMS     |
|                                   |                | approved: PMS    |
|                                   |                | date: 26/08/2025 |

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LEGEND

- WWTP UPGRADE SITE LOCATION
- PROPOSED WWTP LAYOUT
- SHEET PILING

|      |          |           |     |     |
|------|----------|-----------|-----|-----|
| A    | 26.08.25 | ISSUE     | MOF | PMS |
| rev. | date     | amendment | drn | ckd |

PROPOSED MORTARSTOWN WWTP UPGRADE PROJECT, CARLOW

HYDRODYNAMIC ASSESSMENT

50%ILE CHANGE IN WATER VELOCITIES CONSTRUCTION STAGE SCENARIO



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CARLOW OFFICE:  
INNOVATION CENTRE  
GREEN ROAD  
CARLOW R95 W248

NEWRY OFFICE:  
1 RDC HOUSE  
WIN BUSINESS PARK  
NEWRY BT35 6PH

|                                   |                |                  |
|-----------------------------------|----------------|------------------|
| file location: N:\IE3120\DRAWINGS | scale: 1:1,500 | A3               |
| drawing status: PLANNING          | datum: MALIN   |                  |
|                                   | drawn: MOF     |                  |
| drawing no. IE3120-202            | rev: A         | checked: PMS     |
|                                   |                | approved: PMS    |
|                                   |                | date: 26/08/2025 |

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|                                                                        |                  |
|------------------------------------------------------------------------|------------------|
| IMPACT ON WATER VELOCITIES DURING 50%ILE - CONSTRUCTION STAGE SCENARIO |                  |
|                                                                        | <= -0.18M/S      |
|                                                                        | -0.18 - -0.16M/S |
|                                                                        | -0.16 - -0.14M/S |
|                                                                        | -0.14 - -0.12M/S |
|                                                                        | -0.12 - -0.10M/S |
|                                                                        | -0.10 - -0.08M/S |
|                                                                        | -0.08 - -0.06M/S |
|                                                                        | -0.06 - -0.04M/S |
|                                                                        | 0.04 - 0.06M/S   |
|                                                                        | 0.06 - 0.08M/S   |
|                                                                        | 0.08 - 0.10M/S   |
|                                                                        | 0.10 - 0.12M/S   |
|                                                                        | 0.12 - 0.14M/S   |
|                                                                        | 0.14 - 0.16M/S   |
|                                                                        | 0.16 - 0.18M/S   |
|                                                                        | > 0.18M/S        |

NOTE: THERE IS NO IMPACT ON VELOCITIES DURING THE CONSTRUCTION STAGE SCENARIO DURING THE 50% FLUVIAL EVENT





LEGEND

- WWTP UPGRADE SITE LOCATION
- PROPOSED WWTP LAYOUT
- SHEET PILING

|      |          |           |     |     |
|------|----------|-----------|-----|-----|
| A    | 26.08.25 | ISSUE     | MOF | PMS |
| rev. | date     | amendment | drn | ckd |

PROPOSED MORTARSTOWN WWTP UPGRADE PROJECT, CARLOW

HYDRODYNAMIC ASSESSMENT

50%ILE +CC CHANGE IN WATER VELOCITIES CONSTRUCTION STAGE SCENARIO



IE CONSULTING  
WATER-ENVIRONMENTAL-CIVIL

CARLOW OFFICE:  
INNOVATION CENTRE  
GREEN ROAD  
CARLOW R95 W248

NEWRY OFFICE:  
1 RDC HOUSE  
WIN BUSINESS PARK  
NEWRY BT35 6PH

|                                   |                |                  |
|-----------------------------------|----------------|------------------|
| file location: N:\IE3120\DRAWINGS | scale: 1:1,500 | A3               |
| drawing status: PLANNING          | datum: MALIN   |                  |
|                                   | drawn: MOF     |                  |
| drawing no. IE3120-203            | rev: A         | checked: PMS     |
|                                   |                | approved: PMS    |
|                                   |                | date: 26/08/2025 |

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# Appendix G. Planning Drawings





# Appendix H. Tree Survey Report and Tree Protection Plan Drawings





# Appendix I. Underwater Noise and Vibration Report (Wave Dynamics, 2026)



# AtkinsRéalis



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