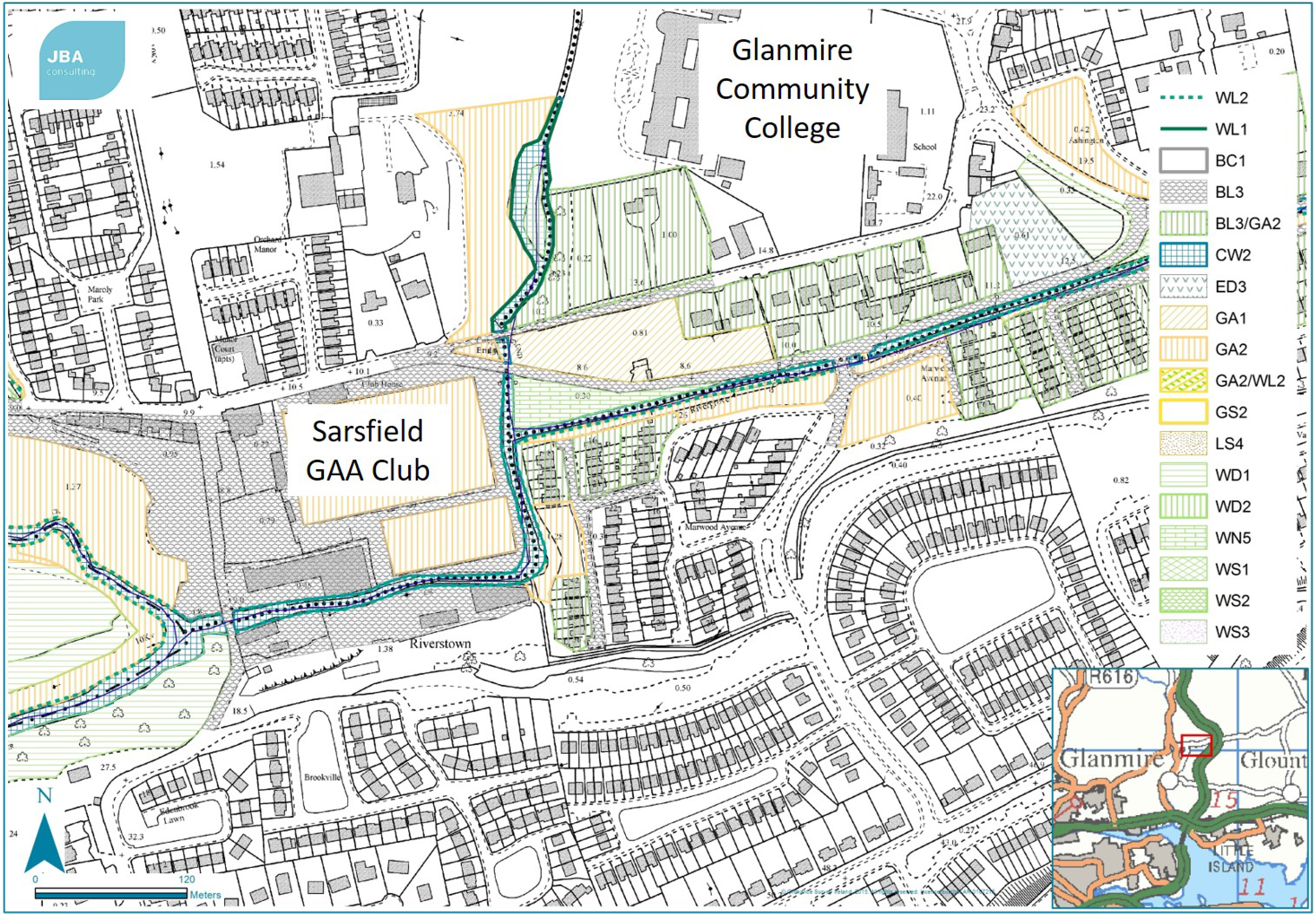

JBA consulting
Glanmire Community College
Sarsfield GAA Club
Riverstown
Marwood Avenue
Brookville
Edenbrook Lawn
Orchard Manor
Marely Park
Club House
School
WL2
WL1
BC1
BL3
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CW2
ED3
GA1
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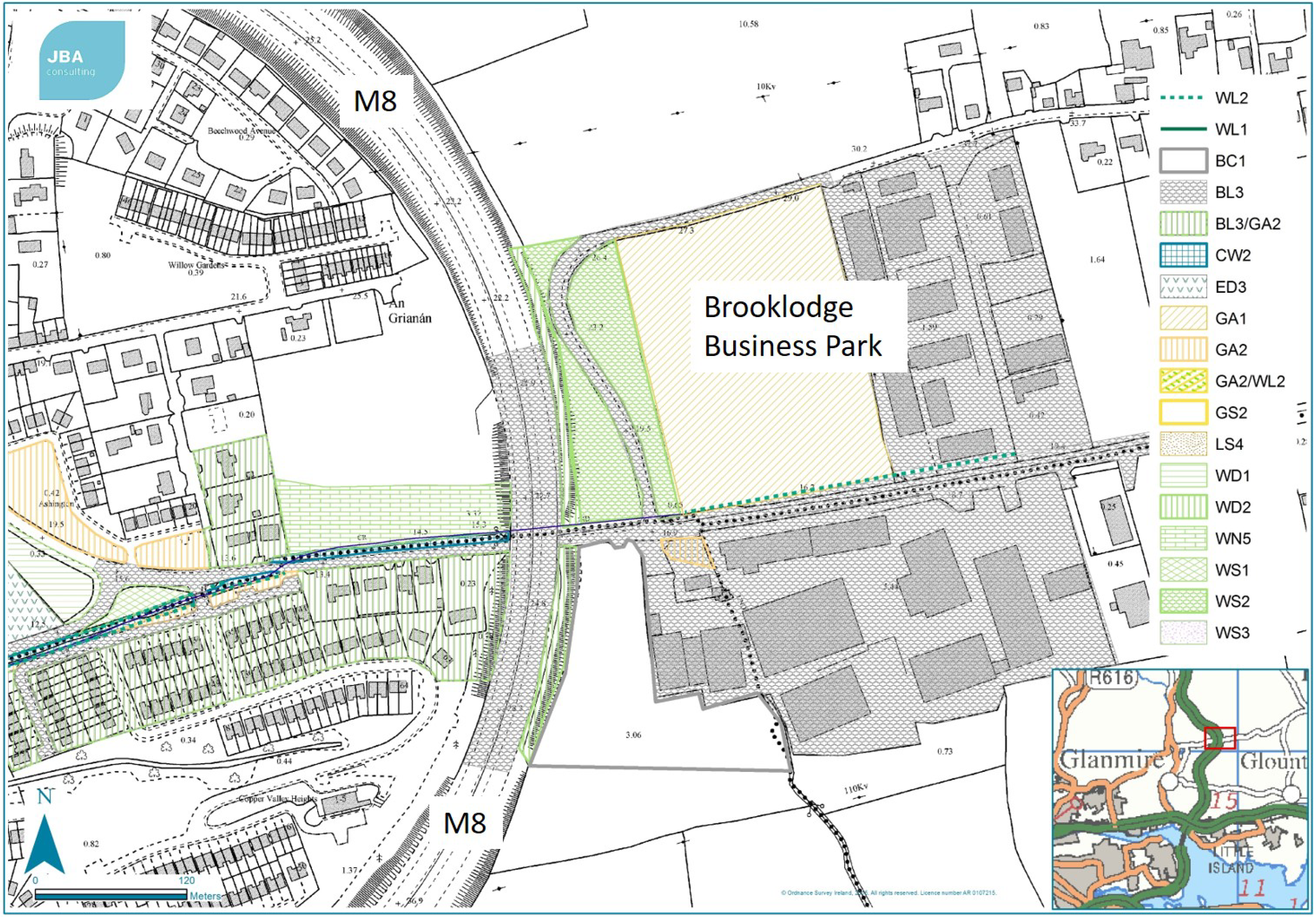

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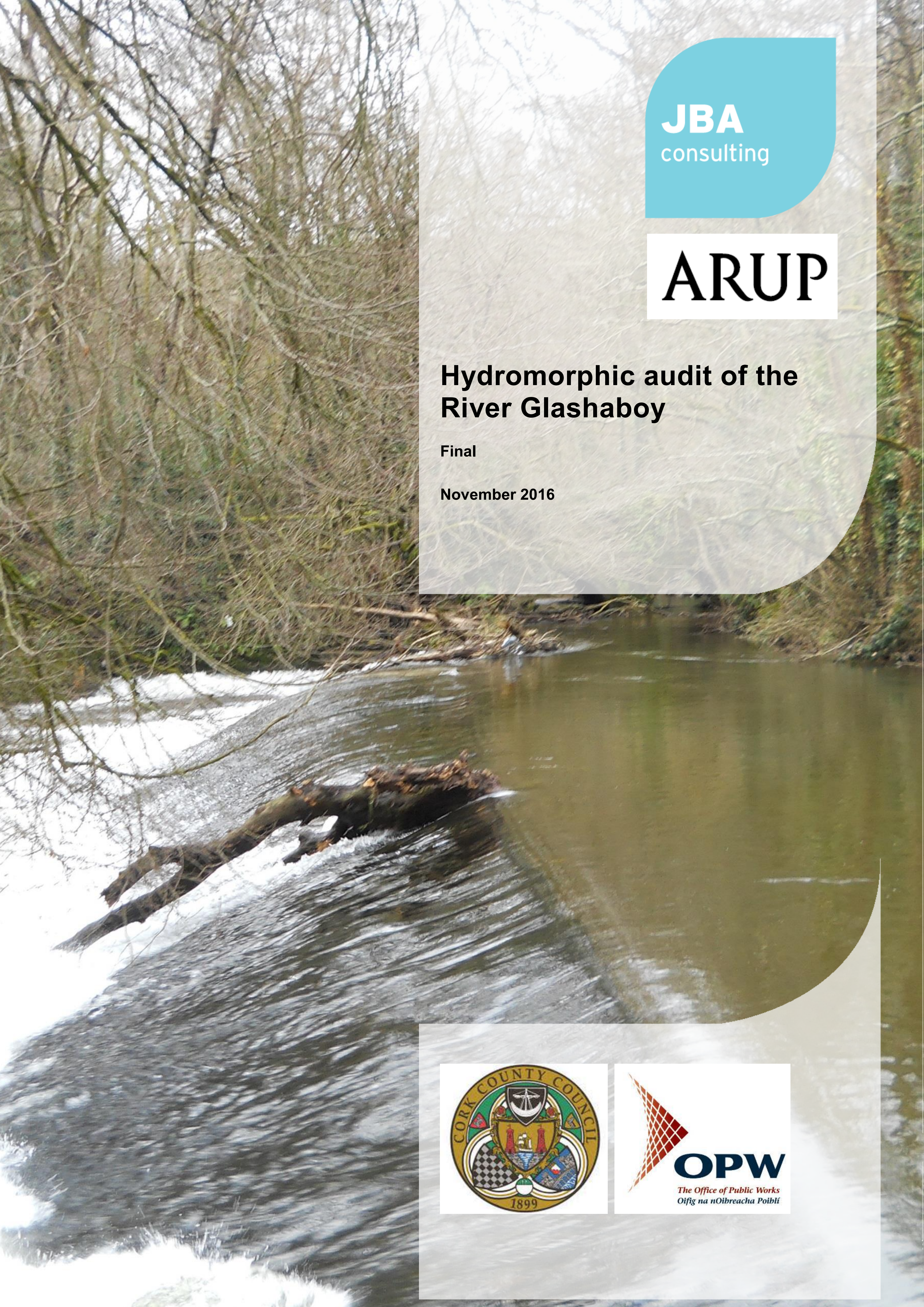
D Hydromorphic Audit of the River Glashaboy



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ARUP

Hydromorphic audit of the River Glashaboy

Final

November 2016

Cork County Council 1899

OPW
The Office of Public Works
Oifig na nOibreacha Poiblí

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Revision History

Revision Ref / Date Issued	Amendments	Issued to
Rev 1 - May 2014	Initial Issue	Steering Group
Rev 2 - August 2016	Addendum including extended FRS works in Appendix 1	Arup
Rev 5 - October 2016	Report update	Exhibition
Rev6 - November 2016	Update for reduced works at in tidal area	Exhibition

Contract

This report describes work commissioned by Cork County Council, by a contract signed in December 2013 by Arup, with JBA Consulting operating as sub-contractors.

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Executive Summary

The geomorphological audit has shown that the Glashaboy is presently not actively transporting much gravel sized material. The river in its upper reaches has good floodplain connectivity, but in its lower reaches, as the urban influences encroach into the channel and floodplain and confine the river corridor, instabilities in the channel occur and erosional processes increase.

Sediment deposition is generally at a low level. The main supply of sediment into the system is from bank erosion, steep tributaries and glacial sediment re-working (in the very upper reaches). Run off from agricultural areas also inputs fine sediment in to the system with limited buffer strips due to a poor quality riparian zone in many locations. Where sediment accumulation issues exist within the system these tend to be as a result of modifications to the channel which has acted to disrupt the natural river system processes. This includes impoundment disrupting the downstream transport of sediment, over widening which reduces channels velocity (increasing sedimentation), channel narrowing increasing velocities (decreasing sedimentation and increasing bank erosion) and poor placement of in channel features and structures.

Opportunities are noted where it is possible to improve floodplain connectivity in several areas upstream of urban locations. This could help reduce flow energy causing erosion in key areas such as adjacent to the shopping centre. However, the opportunities available as a result of the proposed measures is limited and therefore channel erosion mitigation measures will be necessary at vulnerable areas. The steepness of the banks adjacent to the shopping centre though and the limited easement between the top of bank and buildings means careful consideration should be given to bank stability, as the current ad-hoc method of bank protection could lead to long term issues.

Contents

List of Figures

1 Project background and objectives

1.1 Introduction

The geomorphic processes and response to any flood relief scheme are important to understand due to the direct impact that they can have on altering flood capacity and changing flood risk levels. It is also important in terms of maintaining or improving biotic and hydromorphological health through the creation and development of ecological habitats impacting on water body hydro-geomorphological status which is a fundamental component of the European Water Framework Directive (WFD).

The Glashaboy River FRAM study aims to assess and develop a viable, cost-effective and sustainable flood alleviation scheme. This scheme must consider potential system dynamics and associated issues linked to changing patterns of erosion and deposition, ensuring that any depositional sites are minimised and that where sediment is predicted to accumulate that it does not compromise the flood capacity of the scheme. Geomorphological issues linked to erosion and deposition can be efficiently investigated through a desk and site based fluvial audit. The process based knowledge gained from the exercise will inform the development of a conceptual model of system dynamics predicting likely patterns of channel change.

1.2 Assessment Methodology

1.2.1 Overview

The existing geomorphological processes have been assessed through a high level hydromorphic audit involving a catchment baseline survey and local fluvial audit to determine the historic, current and likely future dynamics of the river, paying particular attention to the sediment transport regime (coarse and fine) and associated patterns of erosion and deposition. The audit has concentrated on the Glashaboy River but has also considered wider system response to disrupted / altered flow and transport processes.

The findings of the audit have been used to develop a conceptual model of the form and dynamics of the interacting watercourses allowing predictions of system response to be made regarding potential flood works throughout the catchment. This model will be key in ensuring a sustainable, Water Framework Directive (WFD) compliant solution to the flooding problems is found that minimises hydromorphic impact elsewhere.

1.2.2 Sub-catchment baseline survey

This is a process based audit of the Glashaboy River catchment and tributary channels, providing a clear and simple qualitative understanding of how the river system functions. The audit required a walkover survey associated with a review of online archival sources (aerial photographic evidence, historic flow data, archive planform change information from OS maps and previous studies of the regional geomorphology where available) together with any information provided by the client.

1.2.3 Fluvial audit

The fluvial audit includes a field based survey reviewing the present state of the watercourse morphology and active processes. It identifies key locations where erosion and deposition are impacting on the river and links this to the wider sediment delivery, transport and storage regime to assist in sustainable scheme design and minimise future maintenance requirements.

1.2.4 Development of regional channel change models

The baseline and audit information have been utilised to construct a larger scale cascading model of sediment flux through the catchment and drainage network based on local channel character with channel segments responding to adjacent and upstream sediment inputs. The model also predicts potential channel evolution to altered flow and catchment conditions in the catchment and locally, potentially allowing targeted action at sediment source areas which will reduce erosion and deposition problems through the scheme.

2 Existing Catchment Conditions

2.1 Overview

The Glashaboy River rises in the Nagles Mountains to the North of Cork and flows in a southerly direction entering the Upper Cork Harbour downstream of Glenmire. The upper reaches are predominantly rural, however, the catchment becomes more urbanised in its lower reaches.

The geology of the catchment is predominantly sandstone till overlain by a cover of acid brown earth soils offering free drainage. The lower reaches are underlain by limestone. Low hills dominate the catchment with steeper sloping valleys located to the north.

The Glashaboy catchment is drained by a number of watercourses, the main one being the River Glashaboy which drains land to the west of the catchment. The Butlerstown River and Glenmore River join the Glashaboy at Genmore and drain land to the east.

The lower reaches of the Glashaboy are tidally influenced (up to Glanmire). The fine sediment dynamics of the Cork estuary result in deposition of extensive mud flats through Lough Mahon. However, there is no significant deposition of tidally derived silts along the Glashaboy, suggesting that depositional processes are largely controlled by fluvial processes.

2.2 Water Framework Directive status

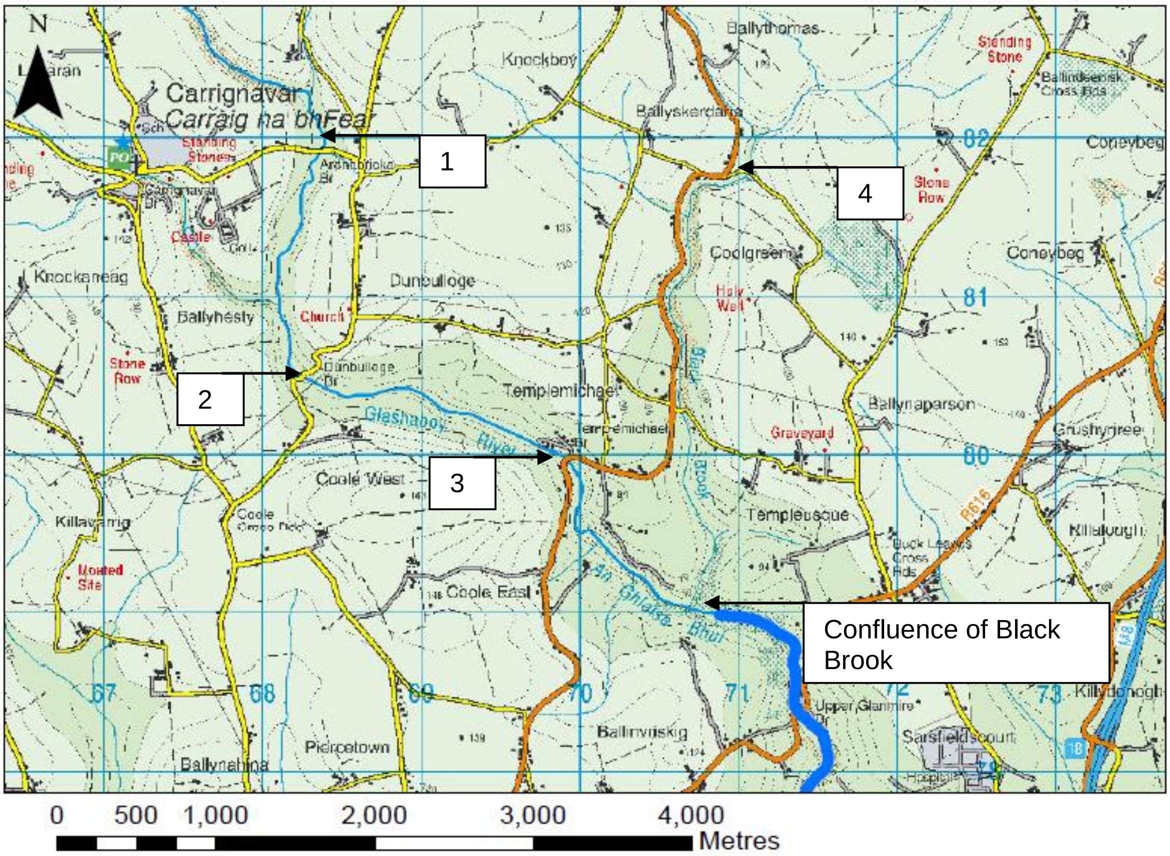
The Glashaboy River is currently classed as being at a Moderate status, whilst its tributaries the Glenmore River and Butlerstown River are classed as being at Good status (with the upper reaches of the Butlerstown river classed as moderate status). All reaches need to achieve 'Good Ecological Status' by 2027.

3 Fluvial Audit

This section of the report summarises the qualitative findings of the hydromorphological / fluvial audit conducted on the Glashaboy River and the lower sections of the Butlerstown River and Glenmore River during April 2014 and August 2016, following the large flood events of 2015. Tidal reaches were visited at low tide to maximise the opportunity to view the bed conditions within the watercourse / estuary.

3.1 Carringnavar to Upper Glanmire Bridge

Figure 3-1 Survey Reach Overview



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The upper sections of the Glashaboy between Carringnavar to Upper Glanmire Bridge (1 to 2 on Figure 3-1) are predominantly rural. The floodplain in most locations is narrow and dominated by farmland and woodland. The channel exhibits a pool-riffle morphology which is dominated by a cobble and gravel bed, with little evidence of significant transport of cobble and gravel sized material given the amount of bed algae present across this sediment (Figure 3-2). Limited large accumulations of gravel as bar features were noted even in areas where the gradient was reduced. This suggests a limited upstream supply of gravels and/or the ability of the channel to flush sediment downstream during higher flow events.

Stable vegetated bars were common throughout the reach (Figure 3-5) along with small pockets of fine sediment deposition along the lateral edges of the channel, mainly from localised bank erosion. Small areas of deposition like this are often an indication of the channel naturally attempting to narrow as a result of historic intervention, such as over widening. Several low weirs exist (see example in Figure 3-2), which cause limited upstream impoundment, but act to cause increased fine sediment deposition within their impoundment zones. Limited evidence was noted of weirs restricting movement of gravels.

Evidence within the reach of historic channel management exists, including old dredging embankments (Figure 3-3) and channel straightening. Channel straightening and dredging has led to some disconnection of the channel from its floodplain in certain areas (although this is not excessive in the upper reaches). Modifications to the channel such as dredging and straightening concentrates in-channel energy, due to reduced stream length. This may also explain the lack of gravel deposition seen in some areas.

Opportunities exist to improve connection through embankment removal and re-grading (Figure 3-5). This should act to improve floodplain storage in these upper reaches and act to reduce downstream flood risk.

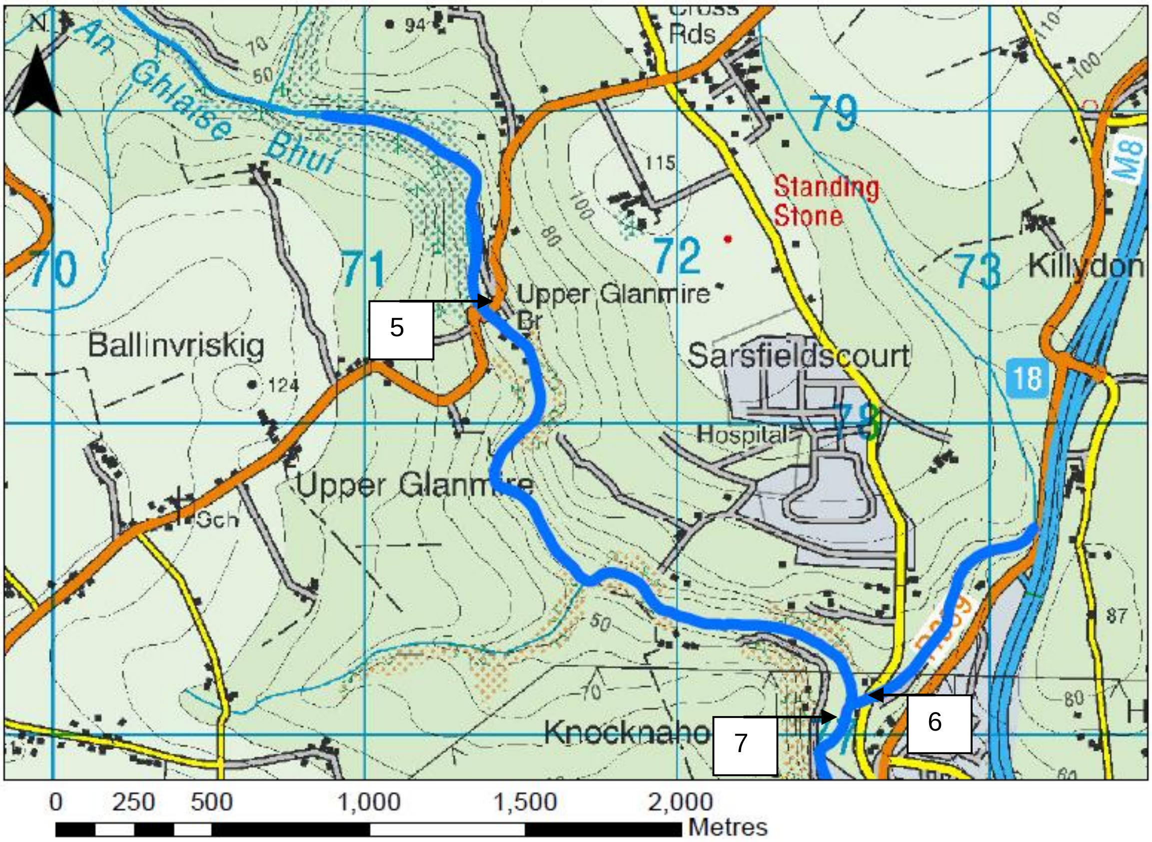
Figure 3-2 Ardnabricka Bridge (Point 1)

Figure 3-3 Dunbulloge Bridge (Point 2)

Figure 3-4 Templemichael Bridge (Point 3)

Figure 3-5 Upstream of Ballyskerdane Bridge (Point 4)

3.2 Upper Glanmire Bridge to Knocknahorgan



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In the reach between Upper Glanmire Bridge and Knocknahorgan the river valley narrows which results in a confined floodplain. At Upper Glanmire Bridge a weir is leading to local bank erosion (Figure 3-6), due to the direction of flows passing under the bridge. Banks have been reinforced using gabion baskets, however, in the long term the river may undercut these baskets.

Downstream of Upper Glanmire Bridge, flow energy in the channel reduces and areas of gravel and small cobble deposition occur (sizes of gravels range from 4cm to 40cm). Gravel splays occur at tributary confluence points (Figure 3-6) along this section, suggesting an active supply of gravels is present from the steep tributaries joining the river (Figure 3-7).

Figure 3-6 Upper Glanmire Bridge (Point 5)

Like the upper sections above Glanmire, bankside vegetation remains dense in many places which acts to improve bank stability through cohesive root networks. In areas where vegetation was less dense small pockets of erosion were noted, but this was certainly not widespread.

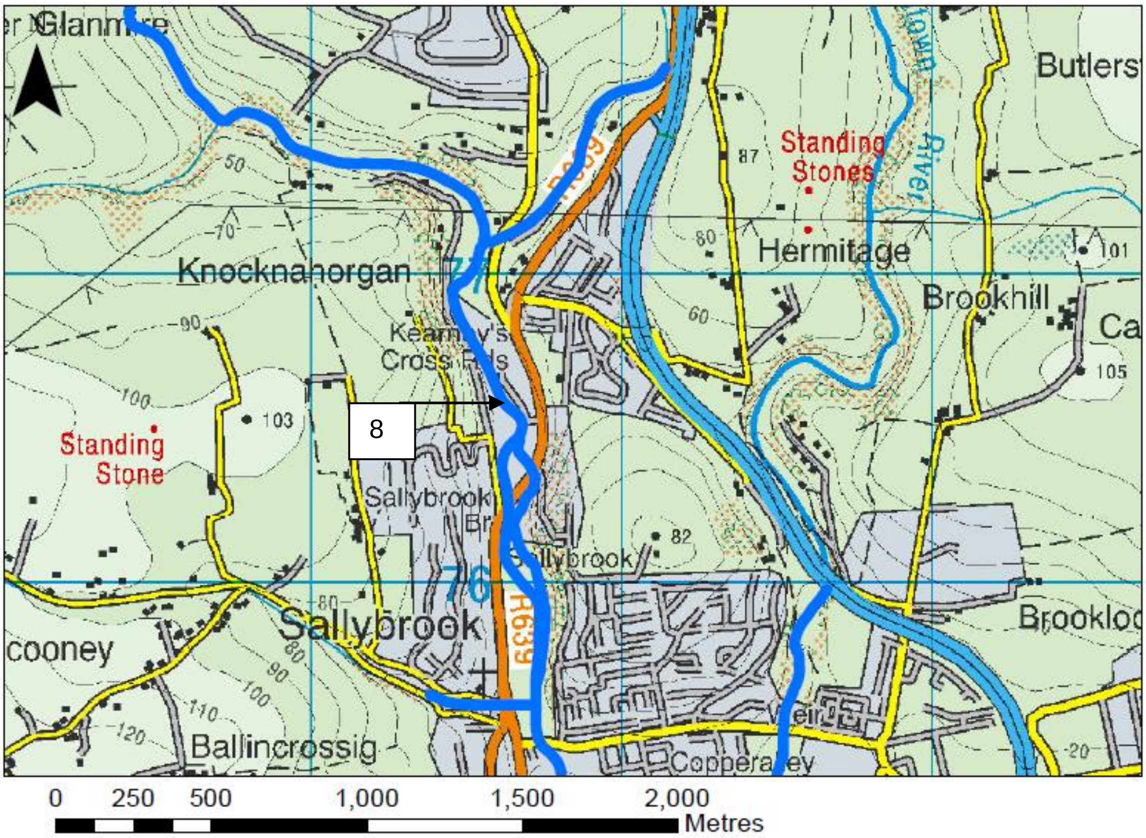
Figure 3-7 Knocknahorgan tributary (Point 6)

Figure 3-8 Knocknahorgan (Point 7)

The channel bed throughout this reach is again dominated by gravels and cobbles, in a plane bed and pool riffle morphology. Less algae was seen on the more gravelly sections on the bed which suggests a more active supply and movement of gravels through this reach (Figure 3-8).

3.3 Knocknahorgan to Sallybrook

Figure 3-9 Reach overview



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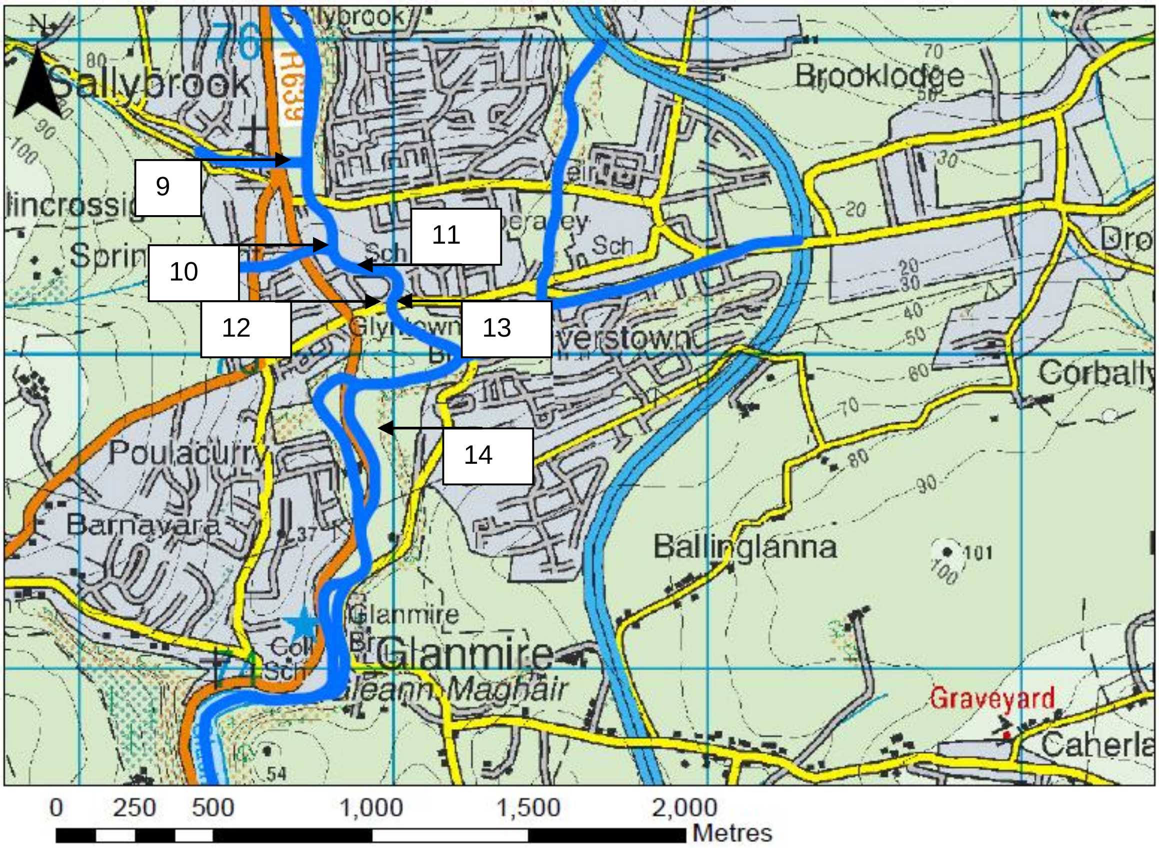
As the river approaches Sallybrook the channel and its floodplain become subject to greater urban influences including embankments, weirs and limited floodplain connectivity due to the presence of flood embankments.

Figure 3-10 Channel upstream of Sallybrook (Point 8)

As the channel approaches Sallybrook the valley widens and becomes less confined. The wider floodplain along this reach has been developed / built upon which acts to constrict the channel. In some areas informal flood embankments have been constructed. In other areas active bank erosion is occurring as the channel attempts to naturally adjust within is confined channel. This is exacerbated by the higher energies during flood conditions as a result of the channel constriction. Hard measures, such as walls have been constructed to reduce the erosional impact of the river (particularly on the outside of bends) and some of these are now failing (such as adjacent to the petrol station). The erosion of banks acts as a strong sediment supply of gravels and fine materials. Deposition is also common through this reach, with several gravel bars (which are unvegetated, signalling frequent movement) being present. However, in the lower portions of the reach the channel becomes incised as a result of the influence of old mill leats and weirs (some existing and some now removed). As a result of these structures the channel is disconnected by over 1m from the floodplain (due to the channel eroding downwards in an attempt to adjust its bed gradient) and deposition is minimal, due to floodplain disconnection and high in channel energy levels. The channel in this lower section is dominated by coarser cobbles.

3.4 Sallybrook to Glanmire

Figure 3-11 Reach overview



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Downstream of Sallybrook the channel flows through a narrow urban corridor. The channel remains slightly incised, possibly due to historic straightening due to protected river banks. Sediment is delivered to this reach via several steep tributaries.

Figure 3-12 Downstream of Sallybrook (Point 9)

Figure 3-13 Adjacent to the Glanmire shopping centre (Point 10a)

Figure 3-14 Adjacent to the lower area of the Glanmire shopping centre (Point 10b)

At the Glanmire shopping centre several areas of bank instability exist (Figure 3-13 and Figure 3-14). The channel at this point is confined and relatively narrow compared to reaches upstream. There is limited deposition due to the steepness in some sections and disruption from upstream to the sediment transport process. The channel banks are high in most locations due to land raising and embankments. As a result, during flood conditions all energy is concentrated within the channel which is leading to bank erosion and instability. In many places existing bank protection has been undermined and has collapsed into the river. This section appears to be starved of sediment, suggesting upstream structures, such as the old weirs are influencing in-channel processes. As a result, the channel has excess stream power leading to the erosion processes along the beds and bank. In order to reduce the flood impact and erosion within this section various options could be investigated including flood storage options upstream and also improving the in-channel morphology which is currently degraded, to manage the existing high energy conditions.

Downstream of the shopping centre the channel widens slightly. Flood defences exist, which protect an adjacent housing estate. The defences act as a constraint to the channel in terms of its floodplain connection. The wider nature (Figure 3-15) of the channel here has allowed for the deposition of some sediment (dominated by fines). In the majority of cases the depositional features are vegetated which suggests that the channel has reacted following past intervention (i.e. it has adjusted to a more natural narrow channel), probably as a result of the construction of the flood defences. This indicates that if any future maintenance of this section occurs (such as sediment removal or flood defence improvements) deposition of this nature will continue to occur.

Figure 3-15 Defences downstream of the Glanmire shopping centre, adjacent to the housing estate (Point 11)

Downstream of the housing estate the channel enters a parkland area and connection to the floodplain is improved. In areas of the channel where flows are reduced fine sediment deposition is occurring (Figure 3-16) and in some areas small pockets of gravels (Figure 3-17) have been deposited, however, gravel deposition is not widespread. If sediment is removed as part of any future maintenance works, it should be expected that sedimentation will re-establish itself naturally.

Figure 3-16 Upstream of the park (Point 12)

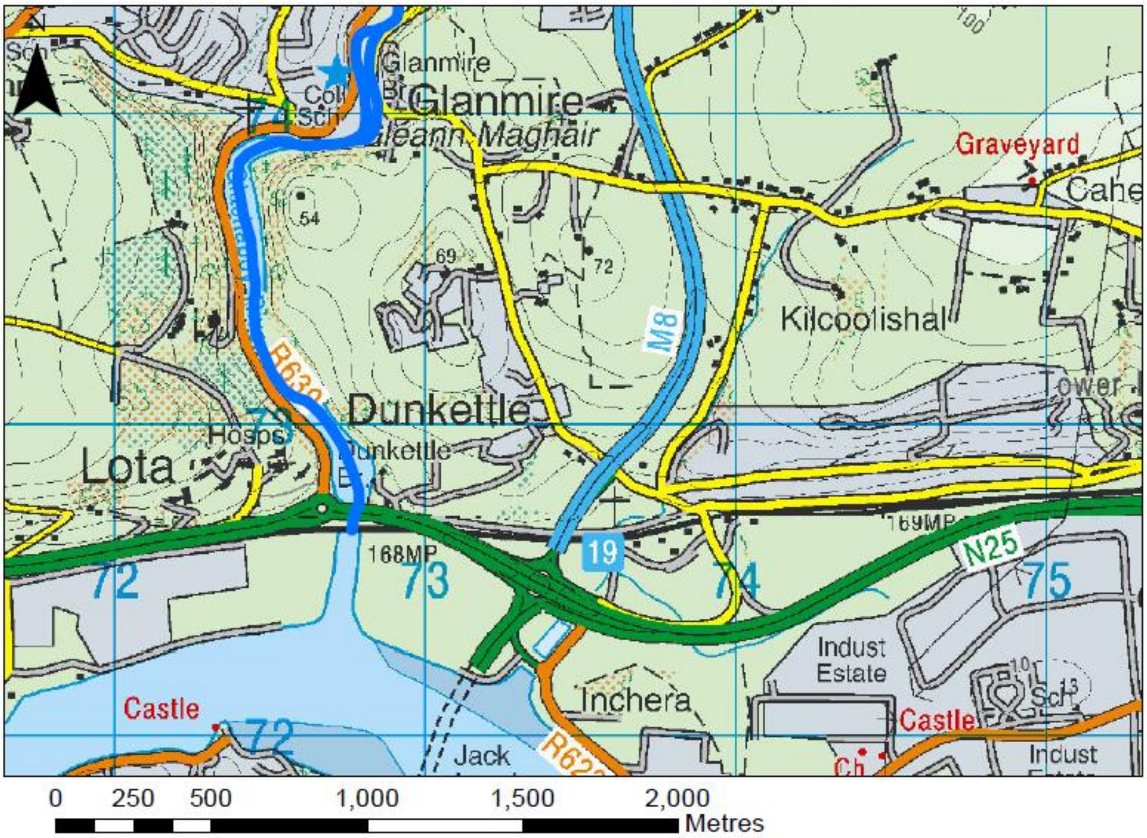
Figure 3-17 Parkland area (Point 13)

In the downstream section of the park a weir exists, which historically was used to feed a mill leat (which is still active). This causes upstream impoundment through the park increasing fine sediment deposition (Figure 3-18). Downstream of the weir some minor scour has occurred along with a small area of gravel deposition, in a classic weir pool morphology. The channel then enters a canalised section with steep walls on both banks which act to prevent any channel migration. As a result, flows within this section have the ability to transport gravels downstream resulting in little deposition apart from coarser sediment at the edges of the channel through this section.

Figure 3-18 Impoundment (Point 14)

3.5 Glanmire to Lough Mahon

Figure 3-19 Reach overview



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At Glanmire bridge, deposition of gravels is occurring on the left bank (Figure 3-20). Downstream of the bridge the river gradually becomes wider and eventually is influenced by the tidal regime. This influences water levels and flow conditions downstream of Glanmire, resulting in some deposition of tidally derived muds and silts. The deposition of this sediment appears low therefore there is little risk of increased sedimentation in this section.

Figure 3-20 Sections downstream of Glanmire

 

3.6 Summary system function

The upper sections of the Glashaboy are generally steep and well connected to the floodplain. The upper sections of the channel are generally stable with a stable armoured bed (vegetated in parts). Fine sediment being delivered from upstream is generally at a low level and this material appears to be moving through the upper part of the system rather than accumulating as bar deposits. However, more evidence of fine sediment deposition was noted in the lower, more modified reaches of the channel. Gravel inputs from upstream appear limited, however several steep tributaries deliver gravels into the system at regular points along the reach.

In the lower reaches, the channel is sensitive to surrounding urban land use and past historic modifications. In some modified sections the channel has become degraded (i.e. a lack of flow has resulted in excessive fine sediment deposition) and in other sections in channel measures to modify the channel are not working with in-channel processes (such as deposition and transportation). As a result, several significant areas of bank erosion and instability exist. These influence local sediment supply and deposition. In most cases ad-hoc bank protection has been used, but evidence suggests after several years this will fail and / or require maintenance.

Tidal fine sediment inputs are similarly very low. The deposition of this sediment appears low (i.e. no large accumulations) therefore there is little risk of increased sedimentation in this section.

4 Flood Relief Options Review

4.1 Introduction

Due to the iterative nature of design of a flood relief scheme, further works were identified after the first audit and assessment. These addition activities are discussed in Appendix A.

4.2 Sallybrook Industrial Estate

4.2.1 Option 1A

Figure 4-1 Typical conditions upstream of the industrial estate

This is a moderately active section of the channel upstream of the mill leat with a gravel / cobble bed that is partly mobilised during higher flows. The river is disconnected from its floodplain in several locations through this reach as a result of informal flood defences. This elevates in-channel energy levels during higher flows, preventing formation of significant gravel features. Under existing conditions, flow velocities vary between 1.0-2.4m/s for bankfull flows upstream of the mill leat, that are capable of moving medium to large gravels. Downstream of the old mill, the channel is moderately incised and the channel bed is dominated by cobbles. Bankfull flow velocities through this section range from 0.2-2.2m/s.

The proposed works for this reach appear to be formalising the existing flood embankments and creating a flood defence wall that ranges between 0.6-1.1m above existing ground levels and tying into existing embankments at one location. As the channel is already moderately disconnected form the floodplain as a result of incision and the informal flood embankments, there is a moderate impact on existing flow hydraulics for the Q100 and Q2 event, with flow velocities increasing by 0.1-0.2m/s. This is unlikely to significantly change the sediment regime through this reach.

As a result, there may be a low level increase in delivery of sediment to downstream reaches as a result of the elevated energy levels created by the increase in length of flood defence embankment.

4.3 Hazelwood Shopping Centre

Figure 4-2 Typical conditions adjacent to the shopping centre


This reach is an active section of the river, with bank erosion common. Bank erosion is particularly occurring on the bend upstream of the confluence. There is a decent supply of sediment from upstream and adjoining steep tributaries. Historic straightening, possible dredging, informal flood embankments and bank protection works all act to increase energy levels during the channel during elevated flows as a result of the disconnected floodplain, loss of channel length through straightening and restriction of lateral processes. The channel is also relatively narrow through this section when compared to upstream reaches which again increases in-channel energy levels during elevated flows. This means there are few depositional features on the channel bed despite the strong supply of sediment to the reach.

4.3.1 Option 2A Direct defences (with conveyance improvements on Cois na Gleann Stream)

The set-back defences in the upper part of this reach for this option still allow some connectivity to the floodplain and are therefore unlikely to significantly influence the existing flow and sediment regime at this point. Through the section where new flood walls and embankments are proposed, velocities for the Q100 event increase by 0.2-0.3m/s. Existing velocities of up to 2.4m/s for a Q2 flow are capable of moving large gravels and the increases in velocities as a result of the proposed works will still fall within this mobility range. This quantifies the existing erosion witnessed through this reach.

The proposed works will result in some change to the existing dynamics through the reach as a result in the increase in length of online flood embankments. These are unlikely to help the river reach WFD status objectives although they are unlikely to result in significant deterioration (small risk of change from current).

4.3.2 Option 2B Conveyance improvements (dredging)

Dredging of this reach will increase the carrying capacity of the channel which is achieved through increasing the depth of the channel. The banks through this reach are already steep and unstable and would become even more unstable as a result of the overdeepening created by the dredging. In combination with the high velocities through the reach, bank failure and erosion is likely to increase unless significant protection works are undertaken. There is a strong supply of sediment to the reach from upstream reaches and adjoining tributaries, therefore dredged material will soon be replaced. Removing the sediment from the channel will put the reach into a state of disequilibrium, meaning the channel will seek to redress the sediment balance by increased erosion immediately upstream (risking propagation of incision upstream) and increased local bank erosion.

This option is unlikely to be WFD compliant due to negative impacts on geomorphological conditions locally and upstream.

4.3.3 Option 2C, 2D and 2E Combination of direct defences and conveyance improvements

(Arrangement 1, 2 and 3)

This option is likely to have similar impacts to option 2A as the online flood walls and embankments in the downstream section of the reach are proposed. However, the proposed wider bridge will improve flow and sediment conveyance to downstream reaches, reducing the impacts on the sediment processes here during higher flows and therefore improving sediment continuity as a result of the reduced impounding effect associated to the existing structure.

For option 2D, the localised channel widening could encourage some localised deposition of gravel. The modelling shows a 0.1-0.2m/s reduction in flow velocities at this point, however, the velocities are still energetic enough to transport small to medium gravels.

For option 2E, the new flood relief culvert alongside the bridge is unlikely to achieve significant benefit in reducing energy levels and encouraging deposition of gravel locally as option 2D. The replacement of the downstream bridge will improve flow and sediment conveyance to downstream reaches as a result of the single span footbridge that is proposed. There is a 0.3m/s increase in the Q100 flow velocity immediately upstream of the proposed footbridge that supports this conclusion.

The proposed works will result in some change to the existing dynamics through the reach as a result in the increase in length of online flood embankments. These are unlikely to result in significant deterioration in WFD status (small risk of change from current).

4.4 Meadowbrook Housing Estate

4.4.1 Option 3A Direct Defences (with conveyance improvements on Springmount Stream)

Figure 4-3 Typical conditions adjacent to Meadowbrook Housing Estate

In the section of the river downstream of the shopping centre the channel widens slightly. Flood defences exist on the right bank, which protect an adjacent housing estate. The defences act as a constraint to the channel in terms of its floodplain connection. The wider nature of the channel here has allowed for the deposition of some sediment (dominated by fines). In the majority of cases the depositional features are vegetated which suggests that the channel has reacted following past intervention (i.e. it has adjusted to a more natural narrow channel), probably as a result of the construction of the flood defences and disconnected floodplain over the right bank.

The replacement and building of the flood wall through this reach increases the Q100 flow velocities by 0.1-0.2m/s. These flows are capable of mobilising medium to large gravels. The increase in velocities for flows impacted by the flood walls will result in more sediment being mobilised and transferred to downstream reaches compared to existing conditions.

The proposed works will result in some change to the existing dynamics through the reach as a result in the increase in length of online flood embankments. These are unlikely to result in significant deterioration in WFD status (small risk of change from current).

4.5 Butlerstown / Glenmore

4.5.1 Option 4A Conveyance improvements

This reach of the river is moderately active and has been historically straightened that has acted to increase in channel energy levels during high flows. This prevents formation of any significant morphological features on the channel bed. The structures on the Butlerstown Stream provide a constriction that is likely to impact the flow and sediment regime at higher flows.

The proposed works aim to improve the conveyance through inclusion of flood relief culverts, a new flood embankment and works to existing walls.

The new flood embankment is likely to increase in channel energy levels that may result in erosion and transport of sediment on the channel bed. For the Q100 event, velocities increase by up to 0.5m/s from a maximum of 2.0-2.1m/s within the reach where the new embankment is proposed on the Glenmore Stream. This is a significant increase and could change the channel morphology within this reach as larger gravels will be able to be transported with the higher velocities.

Replacement of the culvert upstream of the M8 on the Glenmore stream will alter the sediment regime as the new culvert will be larger and laid at a suitably slacker gradient. Regrading of the upstream and downstream channel to accommodate the new culvert will cause a local change in geomorphological conditions, and this may alter the sediment dynamics downstream. Use of appropriate mitigation measures for new culverts, as detailed in the Environment Agency guidance will be required. Introduction of some pools and riffle sequences should be considered in this reach.

The potential impacts on the flow and sediment dynamics through the reach along Glenmore Stream may change the geomorphological condition of the channel. Monitoring and appropriate mitigation measures should be used to offset this potential change.

4.5.2 Option 4B Combination of direct defences and conveyance improvements

This option is similar to option 4A with the addition of a flood defence embankment that is to be set back from the channel over the right bank. As the embankment is to be set back on the Butlerstown Stream, there is limited impact on the hydraulics through this reach for the majority of flows. Otherwise, similar impacts to those described above will be experienced.

4.6 O'Callaghan Park to Glanmire Bridge

4.6.1 Option 5A Direct Defences

Figure 4-4 Typical conditions through O'Callaghan Park


This reach is characterised by a moderately active channel with some deposition of gravel and fines and some embryonic riffle pool sequencing. There is an impounded section of watercourse within this reach as a result of the large weir downstream, this creates elevated levels of fine sediment deposition on the channel bed. There is some evidence of bank erosion outside of the impounded area.

Of the works proposed here, the majority are set back flood defences that are relatively minor and protect localised areas that are unlikely to significantly impact the geomorphological processes of this reach. The only section that may result in elevated in channel energy levels for higher flows is the option for a new flood defence wall at St Patricks Mill. This was predicted to increase flood disconnection, and containment of flows in the channel, elevating energy levels that may promote increased erosion of the channel bed and banks. It would have also result in more flow and sediment being conveyed downstream. As a result, the option was discounted in favour of individual property protection.

5 Conclusions and next steps

The geomorphological audit has shown that the Glashaboy is presently not actively transporting much gravel sized material. The river in its upper reaches has good floodplain connectivity, but in its lower reaches, as the urban influences encroach into the channel and floodplain and confine the river corridor, instabilities in the channel occur and erosional processes increase.

Sediment deposition is generally at a low level. The main supply of sediment into the system is from bank erosion, steep tributaries and glacial sediment re-working (in the very upper reaches). Run off from agricultural areas also inputs fine sediment in to the system with limited buffer strips due to a poor quality riparian zone in many locations. Where sediment accumulation issues exist within the system these tend to be as a result of modifications to the channel which has acted to disrupt the natural river system processes. This includes impoundment disrupting the downstream transport of sediment, over widening which reduces channels velocity (increasing sedimentation), channel narrowing increasing velocities (decreasing sedimentation and increasing bank erosion) and poor placement of in channel features and structures.

In relation to potential flood management solutions, opportunities exist to improve floodplain connectivity in several areas upstream of urban locations. This could help reduce flow energy causing erosion in key areas such as adjacent to the shopping centre. However, the steepness of the banks adjacent to the shopping centre and the limited easement between the top of bank and buildings means careful consideration should be given to bank stability, as the current ad-hoc method of bank protection could lead to long term issues. On the tributaries culvert replacement works are planned, and sediment transport processes will be temporarily impacted. The mitigation measures detailed in Environment Agency guidance for culverts and for fish passage will be required to reduce the long term impact of these works. Monitoring of these measures is essential through further audits and channel maintenance activities.

A Appendix 1: Geomorphology Addendum (August 2016)

A.1 C09_B01: Replace existing twin 0.9m dia. culverts with new 1.6m by 1.2m high rect. culvert




Bleach Hill Stream at this location is entrenched (overly deep). As a result there is little floodplain connectivity except when flood water backs up behind the structure. The stream is dominated by a gravel and cobble bed which appears partially mobile (i.e. limited evidence of armouring). During flood conditions it is likely that this sediment will be mobilised and transported downstream, whilst new sediment will be delivered from upstream reaches. Due to the existing small culverts some sediment has accumulated upstream of the bridge. Whilst the existing culverts appear to be capable of allowing sediment to move downstream, it is likely that the culverts frequently become blocked with trash and debris which will hinder sediment continuity to downstream reaches.

The proposed larger culvert will improve sediment continuity through the system. The existing bed material should be maintained and matched where possible, however, any disturbance to the bed will quickly be rectified during subsequent high flow events. High flows event will be capable of transporting sediment to the structure from upstream reaches and the bed will quickly re stabilise.

A.2 C01_L01: Concrete flood defence (Old weir at Petrol Stn North of Sallybrook)


There is an impounded reach upstream of an old weir adjacent to the petrol station. The weir is partially collapsed and appears unmaintained. The reach upstream of the weir exhibits low velocities due to the impoundment impacts. The weir has also, over time acted to trap sediment upstream which in turn has elevated the upstream channel bed level.

The main flow route over the weir is towards the left bank (outside bed) at the weir site. The steep gradient of the weir acts to elevate velocities and this has caused outer bank erosion problems.

Measures to protect the banks from erosion have been implemented using boulders and concrete which appear to be working in the short term.

In the long term there is a risk that the existing bank protection measures could fail due to their ad-hoc nature and the old weir structure could fail. If this occurs the existing river bed upstream of the weir will naturally lower as the trapped sediment is released. There may be a case for further investigation to determine the impact of the failure of this old weir structure on both the bed and bank upstream. Works are planned on the left hand bank, and this will stabilise this bank.

Any future failure would release trapped sediment downstream (which may impact structures) and cause upstream bank instability (which may impact the existing and future flood defences and erosion protection measures depending on foundation depth). This issue should be monitored and action taken if conditions deteriorate.

A.3 C08_700: Silted mill race


The redundant weir (noted above) feeds into the mill race shown in the photographs above. This is heavily silted due to the low velocities and limited variation in flow. Limited change is expected in this area following the construction of the new flood defences.

A.4 Cols na Gleann Stream: Replace existing culvert with a new 2m wide by 0.9m high rectangular culvert




The Cols na Gleann Stream is a small steep channel dominated by cobbles and gravels, which appear to readily transported downstream. The channel is very narrow and it is likely that it has been straightened historically. Such modifications act to elevate in channel velocities. Sediment has accumulated upstream of the culvert. Downstream of the culvert the channel gradient reduces and smaller gravels have been deposited (due to the reduced velocities associated with the reduced gradient). Within this area gravels dominate the channel bed and less cobbles are present. The existing culvert appears to disrupt the downstream continuity of sediment due to blockages at the small trash screen and the undersized nature of the bridge.

The proposals at this location should improve sediment continuity downstream. Care will be required to ensure large cobbles do not become trapped against the upstream trash screen (if one is to be constructed) as the high energy conditions will still be present.

A.5 C01_C01, B02, C02: Proposed flood relief channel and culvert

The existing channel at this location is dominated by cobbles and gravels. The bed is partially armoured (evidenced by the moss over some of the larger cobbles) which suggests limited large sediment delivery. However, site conditions suggest higher velocity flows frequently transport smaller gravels through this reach. The construction of a flood relief channel is unlikely to significantly alter existing morphological conditions. However, the invert of the flood relief channel should be set at a point as to not decrease velocity as this could lead to an increase in deposition if in channel velocities are reduced significantly.

The existing bed material should be maintained and matched where possible. High flows event will be capable of transporting sediment; however several flood events may need to pass through the system before the bed restabilises.

A.6 C01_B03: Replace bridge

The channel at this location is currently over wide which acts to influence morphological processes. As a consequence, depositional zones are noted within this reach. (i.e. the over wide nature of the channel may lead to lower velocities which in turn may encourage deposition). The proposed new bridge should not change the existing morphological regime, as the channel width is remaining the same.

Upstream and downstream of this bridge some channel erosion is evident. In particular, downstream of the bridge, existing gabion basket protection has begun to fail on the outside of the bend. An alternative solution to bank protection is recommended at this location.

The existing bed material should be maintained and matched where possible. High flow events will be capable of transporting sediment, however several flood events may need to pass through the system before the bed destabilises.

A.7 C06_B01: Replace existing twin 0.4m dia culverts with a new 1.8m wide by 0.9m high rect culvert

No safe access could be sought to see this culvert on the Springmount stream. However, extensive gravels and sands were present downstream. A wooden weir structure is also in place downstream which acts to impound water upstream for an unspecified distance. This appears to have collected a substantial amount of sediment. If this weir fails it could impact the stability of the channel upstream in the short term. Further investigation should be sought to see if this weir influences flow conditions at the upstream culvert.

A.8 C01_C03: Bridge arch to be cleared by removing vegetation

Sediment was in the process of being removed from the channel during the site visit on the 03/07/16. Sediment was being removed several hundred metres upstream and downstream of the bridge. Some banks remain steeply profiled and could be subject to erosion until vegetation re-establishes.

Nevertheless, it is expected that the channel will quickly recover and new gravel bars will reform and the river attempts to re-establish a sediment equilibrium.

A.9 C09_C01 (channel deepening), C05_B01 (replace culverts), C05_C02 (channel widening), C05_C03 (widening)

Deepening and increasing the culvert size will increase conveyance through the bridge. There will be limited impact on the channel morphology. The weir downstream of the bridge acts to trap some sediment.

The delivery of sediment within this reach appears to be lower than over reaches. This means that the channel may take longer to recover following any in channel works.

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