APPENDIX A

Dunkellin River and Aggard Stream Flood Relief Scheme, Description of the Proposed Works

Galway County Council

Dunkellin River & Aggard Stream Flood Relief Scheme

Description of the Proposed Works

TOBIN CONSULTING ENGINEERS

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REPORT

PROJECT: **Dunkellin River and Aggard Stream Flood Relief Scheme**

CLIENT: **Galway County Council,**
Aras An Chontae,
Prospect Hill,
Galway.

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Title:	**Technical Description for EIS**

PROJECT NUMBER: 6408				**DOCUMENT REF:** **6408-Works Description Section for EIS** **Revision K**			
K	Proposed Scheme	CK	Aug 14	MMcD	Sept 14	MMcD	Sept 14
Revision	**Description & Rationale**	**Originated**	**Date**	**Reviewed**	**Date**	**Authorised**	**Date**
TOBIN Consulting Engineers							

NON TECHNICAL DESCRIPTION

The extent of the overall study area for the proposed *Dunkellin River and Aggard Stream Flood Relief Scheme* has been divided into two distinct channels. These channels are:

1. the Dunkellin/Craughwell River from approximately 200m upstream of Craughwell Village to the sea at Kilcolgan just upstream of where the river enters Galway Bay.

2. the Aggard Stream and Monksfield River from the townland of Cregaclare (near Ardrahan), to its outfall at the confluence of the Dunkellin and Craughwell Rivers.

It is proposed to undertaken flood relief works along the Dunkellin in three reaches of the river:

a. in the vicinity of Craughwell Village,
b. locally at Rinn Bridge and
c. from a location just upstream of the Dunkellin Bridge to the N18 at Kilcolgan.

The works consist of channel deepening (not widening) in Craughwell village to the confluence of the Aggard Stream, local channel widening at Rinn Bridge, out of channel maintenance downstream of the Rahasane Turlough to Rinn Bridge (i.e., limited to trimming back of terrestrial bank vegetation such as trees and low hanging branches and removal of encroaching vegetation such as brambles and scrub) and channel widening from the Dunkellin Bridge to the N18.

It is not proposed to undertake any significant arterial drainage works along the Aggard Stream. The proposed works associated with the Aggard Stream will be limited to the replacement of field wall crossings which are blocked or have collapsed, together with maintenance works, including the non-invasive trimming of bank-side vegetation and the removal of areas of accumulated silt along the full length of the channel.

It is not proposed to undertake works within or adjacent to the Rahasane Turlough cSAC, NHA and SPA or within the Galway Bay Complex SAC.

The requirement for the proposed works are to relieve flooding generated from rainfall events similar to those that occurred in January 2005 and November 2009 which flooded properties in Craughwell Village and a number of townlands along the river including Rinn, Dunkellin and Killeely Beg. To place these works in context the following is a synopsis of the flooding that occurred in region in November 2009.

During the period 17th to 24th November 2009, daily rainfall amounts on Wednesday 19th were recorded as 26.7mm and 29.4mm at the Shannon and Claremorris Weather Stations, respectively. This peak rainfall was followed by peak flood levels :

a. upstream of Craughwell village along the R349 (Loughrea to Athenry Road) at approximately midday on Thursday 20th November,
b. at the Craughwell River/N6 road crossing during Thursday afternoon (road closed in afternoon resulting in significant traffic disruption), and
c. downstream of Craughwell at Rahasane Turlough during Friday 21st November.

The following photography, taken by the OPW & Central Fisheries Board, during the period Thursday 20th to Saturday 22nd November 2009, shows the extent of flooding which occurred in late November 2009.

Photograph A
November 2009 Event.
Looking Upstream from Craughwell

Note the relatively small area (approximately 1.2ha) and therefore volume of flooding in Craughwell village when compared with the extent of lands flooded at the Rahasane Turlough (>350ha) in Photographs B and C.

Photograph B
November 2009 Event.
Looking downstream from Craughwell

Note the relatively small area (approximately 1.2ha) of flooding in Craughwell in the foreground when compared with the extent of lands flooded at the Rahasane Turlough (>350ha) in background.

Photograph C
November 2009 Event.
Looking northwards across the Rahasane Turlough

The width of flooding shown is approximately 0.75 to 1.0km..

The proposed scheme aims to reduce the impact of similar extreme floods, on existing properties, while having minimal impacts, short term only impacts or no impact on local ecology or other sensitive designated areas such as the Rahasane Turlough and Galway Bay Complex.

The proposed scheme has used a series of computer models to establish the design of the excavations required and to also estimate the depth of flooding that may occur if events like January 2005 and November 2009 were to be repeated in the future.

The computer models have used recorded and locally gathered evidence of extreme flooding to establish the extent of the proposed flood relief works that are needed to protect, where possible, long established residential housing and commercial premises in the area.

Table A – Summary of the proposed Proposed Scheme

Location	Proposed Scheme
Main Channel (Craughwell Village)	The main channel shall in general be deepened by 0.6m with a localised maximum excavation of 1.0m.
Bridge Work in Craughwell	Both existing road bridges will require engineering works on each abutment to facilitate proposed channel deepening. Similarly the railway bridge will also require foundation works for the same purposes.
Bypass Channel (Craughwell Village)	The bypass channel is to be cleaned and excavated to alleviate flooding in Craughwell Village.
Rahasane Turlough	It is Not Proposed to Complete any Works within or adjacent to the main body of the Rahasane Turlough cSAC.
Channel Works between the Rahasane Turlough and Rinn Bridge and Works at Rinn	Out of channel maintenance downstream of the Rahasane Turlough to Rinn Bridge (i.e., limited to trimming back of terrestrial vegetation such as trees and low hanging branches and removal of encroaching vegetation such as brambles and scrub) with provision of new flood relief eyes to be constructed on one bank of the river in association with two stage channel widening 50m upstream and 50m downstream of the existing Rinn Bridge.

Channel Works beginning upstream of Dunkellin bridge	Works will commence approximately 175m upstream of the Dunkellin bridge and consist of the construction of a high level channel typically 20m in width along the left bank (as one looks downstream) of the river.
Channel Works from Dunkellin Bridge to Kilcolgan Bridge	Out of channel maintenance (limited to trimming back of bank side terrestrial vegetation to 1.0m to 1.5m above high flood levels) in association with the higher level "Two stage channel works" will continue from Dunkellin Bridge to Kilcolgan Bridge with a typical additional channel width of up to 20m.
Works at Dunkellin Bridge	In conjunction with localised channel widening the existing flood eyes shall be replaced with 2 new box culverts each measuring 13m wide x 2.3m deep. Existing stone from the bridge will be reused to match the retained main stone arch.
Works at Killeely Beg Bridge	In conjunction with channel widening a new bridge shall be provided with an 18m span.
Salmon Counter	The salmon counter will be relocated to a position upstream of Kileely Beg bridge as part of the river enhancement works

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DESCRIPTION OF THE PROPOSED SCHEME

1 GENERAL DESCRIPTION OF THE SCHEME

Following the invitations to tender from Galway County Council, in conjunction with the OPW, in January 2011, and the submission of Tender proposals by TOBIN Consulting Engineers and the RPS Group, both firms (the Design Team) were commissioned by the Council to undertake two service contracts, namely;

Service Contract 1: *"Dunkellin River and Aggard Stream Flood Relief Scheme - Engineering Consultancy Services",* a contract being undertaken by TOBIN Consulting Engineers,

and

Service Contract 2: "Dunkellin River and Aggard Stream Flood Relief Scheme - Environmental Consultancy Services", a contract being undertaken by the RPS Group.

The brief required TOBIN Consulting Engineers to review the proposed flood alleviation measures, contained in the report entitled *"Study to Identify Practical Measures to Address Flooding on the Dunkellin River including the Aggard Stream"* and dated June 2010, with a view to establishing a series of viable technical solutions, which address the environmental constraints which emerged as part of the planning stage and from the public consultation process undertaken in May 2011.

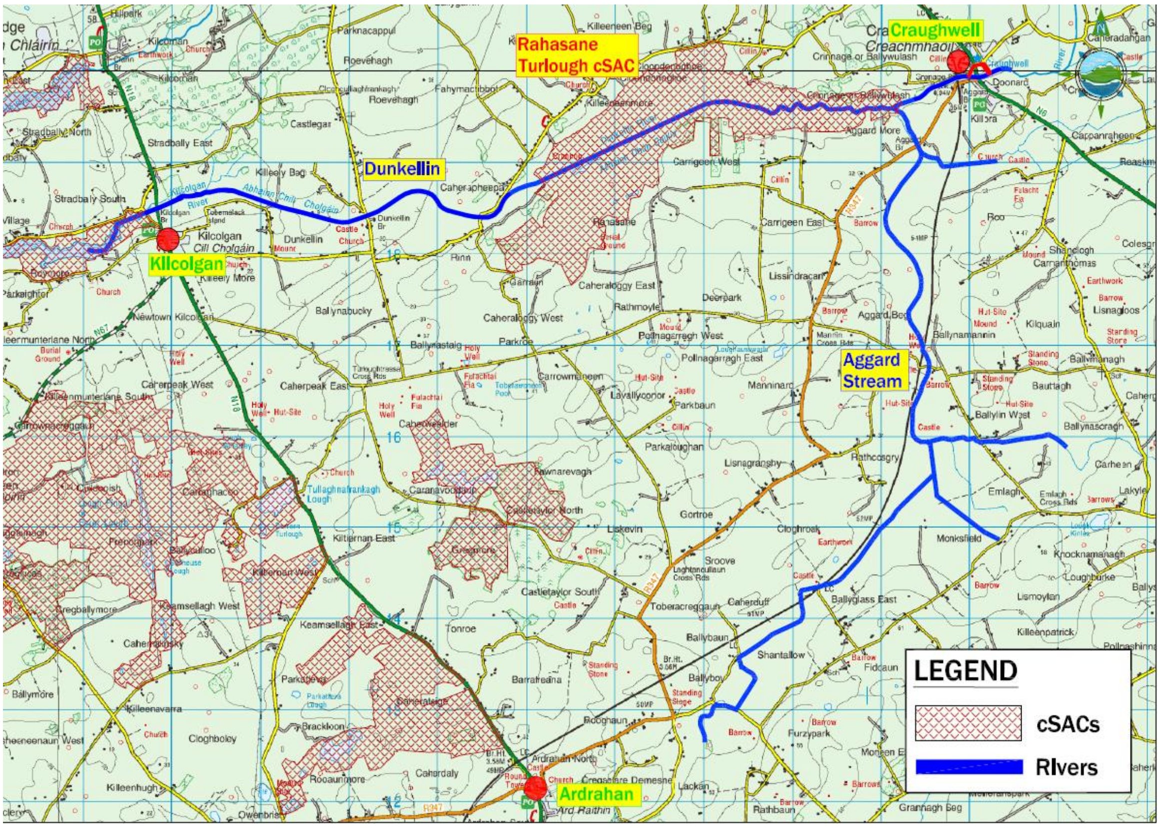


Figure 1-1 – Extent of the Study Area

The extent of the overall study area, as shown in Figure 1-1, has been divided into areas contributing to two distinct channels. These channels are:

3. the Dunkellin/Craughwell River from approximately 200m upstream of Craughwell Village, through the Rahasane Turlough cSAC, NHA and SPA, to the sea at Kilcolgan just upstream of where the river enters the Galway Bay Complex SAC.

4. the Aggard Stream and Monksfield River from the townland of Cregaclare (near Ardrahan), to its outfall at the confluence of the Dunkellin and Craughwell Rivers.

Whilst the Dunkellin River drains a significant area of lands to the east, northeast and south of Craughwell village (>200km^2), the particular reaches of river considered in this project are:

1. approximately 11km of the Dunkellin River which runs in a westerly direction from Craughwell Village to the sea at Kilcolgan.
2. approximately 7.5km of the Aggard Stream which flows in a northerly direction from Ardrahan to Craughwell.

It is not proposed to undertake any significant arterial drainage works along the Aggard Stream. The proposed works associated with the Aggard Stream will be limited to culvert replacement and the replacement of field wall crossings, together with maintenance works, including the non-invasive trimming of bank-side vegetation and the removal of areas of accumulated silt along the full length of the channel.

The Dunkellin River and its tributaries, rise at a number of locations to the east of Craughwell, and drain a number of population centres, including Woodlawn (Raford or Dooyertha River) and New Inn (Craughwell River), Cappataggle and Lough Rea (St Cleran's River) to name a few. Flows from each of the upper sub-catchment areas, combine to form the main channel reach at Craughwell Village, where the discharge is recorded at an OPW gauging station (Station No. 29007) on the main R446 (formerly N6) Road Bridge.

Figure 1-2, shows the extent of the Dunkellin River, from Craughwell Village to Kilcolgan, and the positions of the major hydraulic controls along this particular stretch of river.

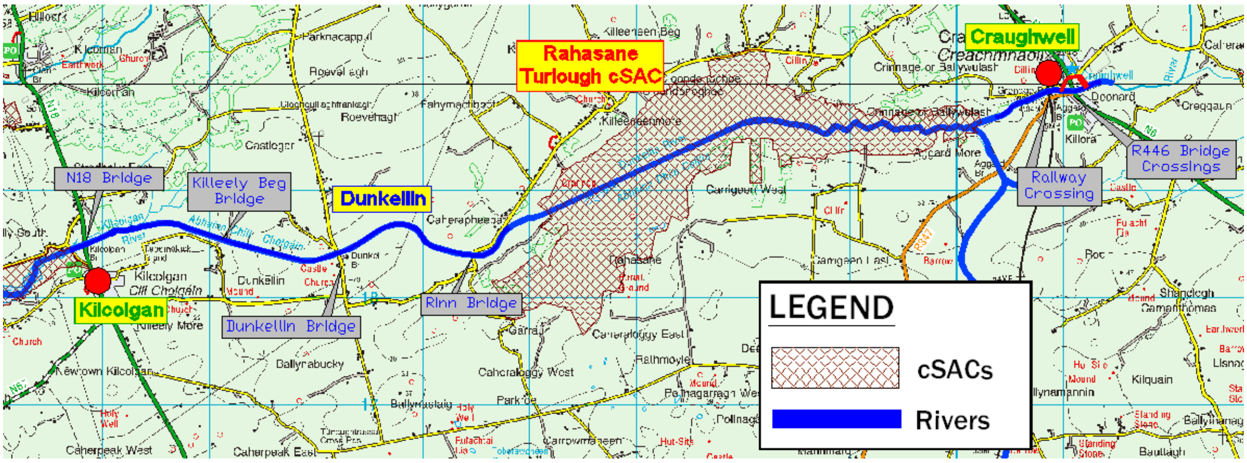
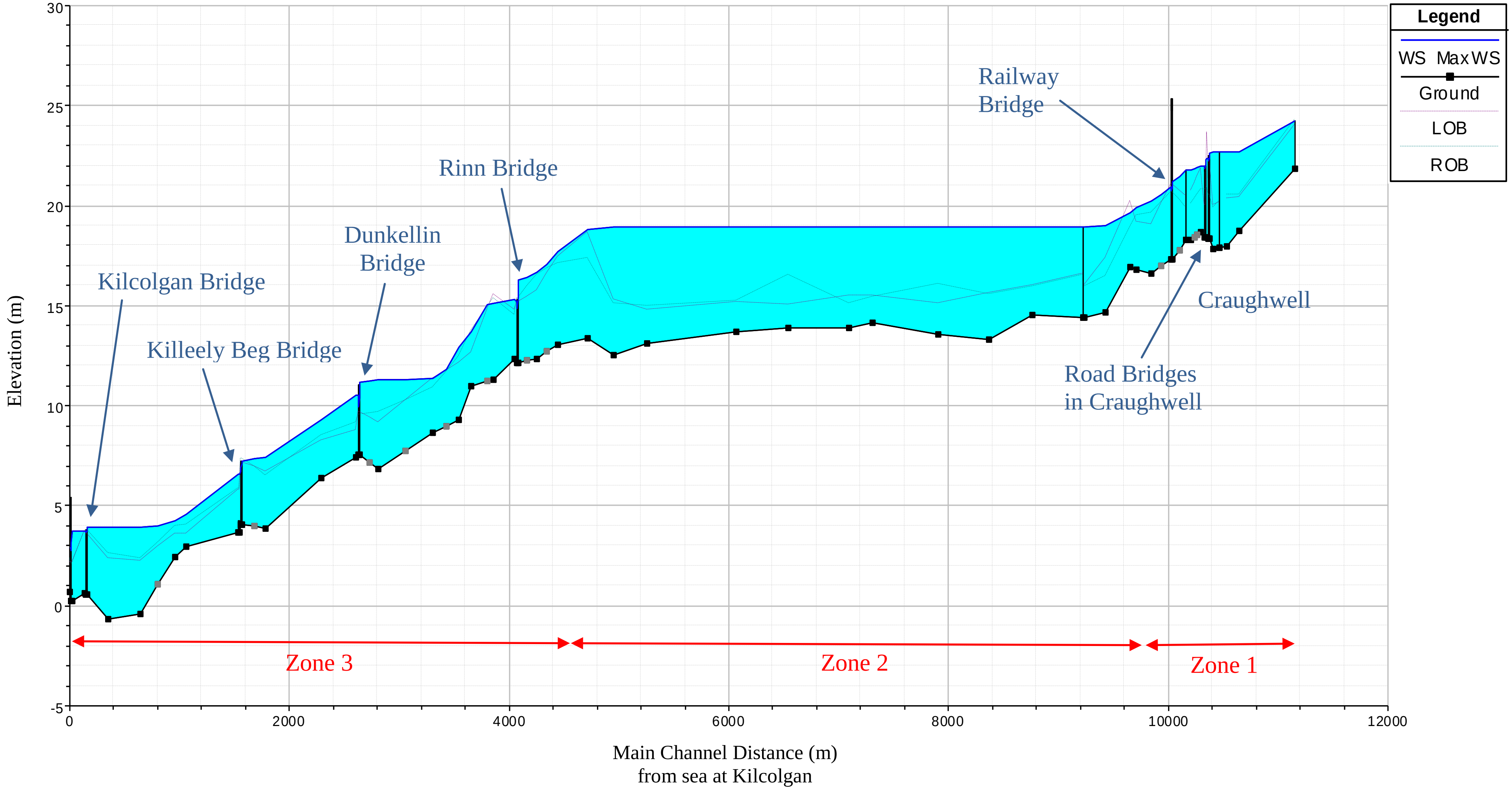


Figure 1-2 – Dunkellin Catchment from Craughwell to Kilcolgan

Figure 1-3, shows the longitudinal section of the Dunkellin River, from Craughwell Village to Kilcolgan, which was modelled using the hydraulic software package, HEC-Ras. It details the estimated surface water profile for the November 2009 event and compares this with the channel bed, left bank (LOB) and right bank (ROB).

Figure 1-3 – Longitudinal Section of the Dunkellin River from Craughwell to Kilcolgan



The depth of the main Dunkellin River channel varies quite considerably throughout its course. Natural embankments formed from excavated spoil, significant rock cuts and large flat flood plains, are predominant physical features of this channel.

The bed profile of the Dunkellin River, from Craughwell to Kilcolgan, as shown in Figure 1-3, ranges from a level of 22.29mOD (Malin Head) in Craughwell village, to 0.88mOD at Kilcolgan Bridge, and has three (3) zones along its length.

Zone 1 – Craughwell River, which has a relatively steep gradient in bed level at Craughwell Village.

Zone 2 – Rahasane Turlough cSAC, NHA and SPA, which has a gentle undulating bed level.

Zone 3 – Lower reach of the Dunkellin River, which has steep gradients in bed level from upstream of Rinn Bridge, to the sea at Kilcolgan.

These zones are described in more detail in the following sections and are used throughout this section to discuss the proposed flood relief measures.

1.1 ZONE 1 – CRAUGHWELL RIVER

This particular stretch of the Craughwell River in the village of Craughwell, consists of two distinct channels, namely,

a. the main channel and
b. the bypass or overflow channel.

During normal flow conditions, surface water flows are restricted to the main Craughwell River, coloured blue in Figure 1-4, and pass under two bridge crossings namely; the main R446 Bridge (formerly N6) and the old multi-arched stone bridge.

However, when flow conditions dictate excess surface water flow is directed around the main bridge crossing via an overflow channel and a further bridge crossing of the R446, highlighted in red on Figure 1-4. The effectiveness of this overflow channel (bypass channel) is limited, as it is not fully connected to the Craughwell River at its upstream location. High flows must follow a short section of overland flow before entering the overflow channel.

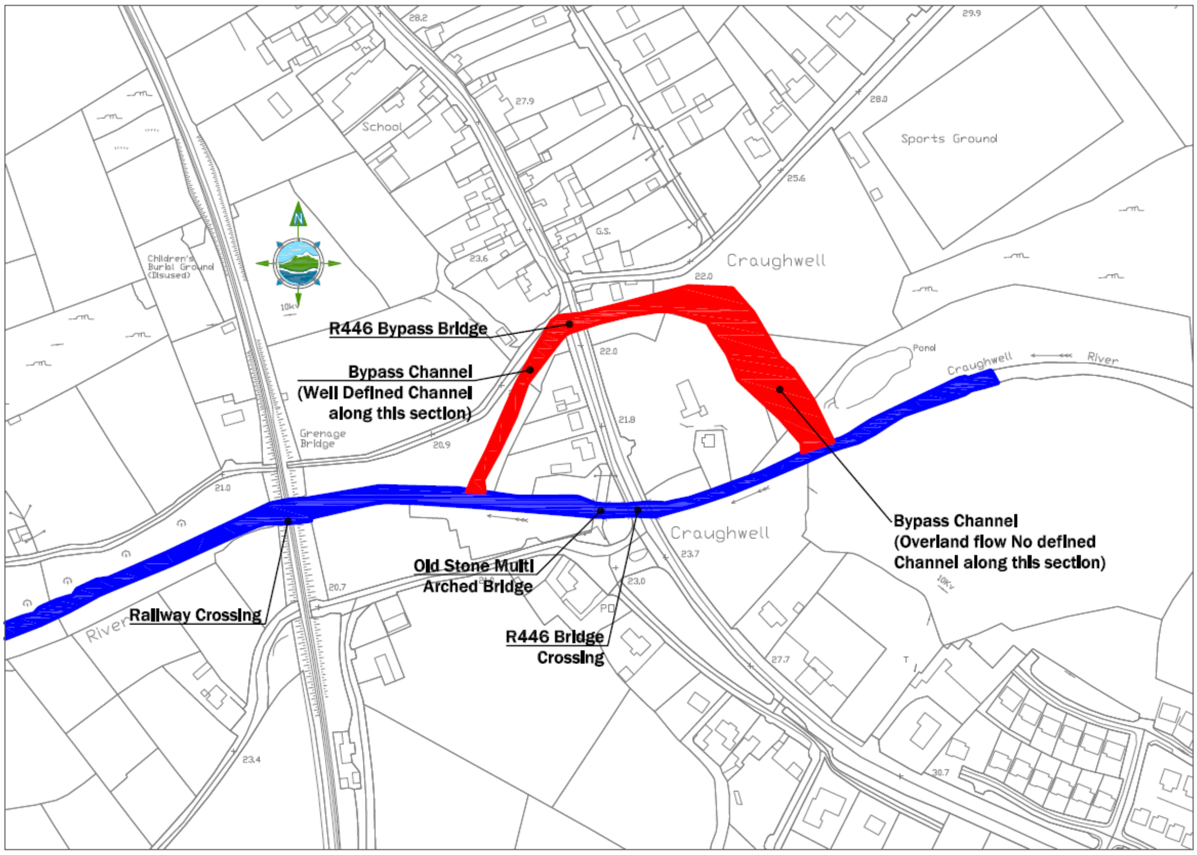


Figure 1-4 – Zone 1 Craughwell River at Craughwell Village

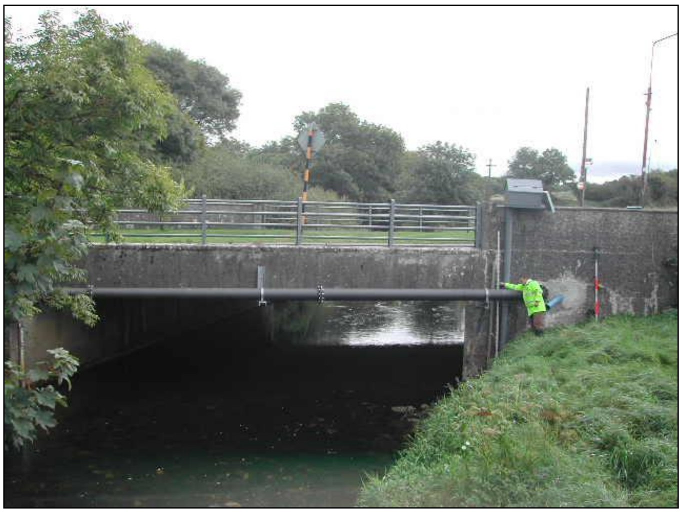
The channel along this stretch of the Dunkellin River, is of the order of 1.4m to 2.0m deep and the bed level gradient varies considerably, with a change in bed level occurring within Craughwell Village at the three bridge crossings.

There are a number of hydraulic controls along this stretch of the river. These controls are shown in the following photography and are :

a. The overflow or bypass channel within Craughwell Village (Photograph No. 1),
b. The two road bridges (Photograph No's. 2 and 3),
c. The old multi-arched stone bridge (Photograph No. 4) and
d. The railway bridge (Photograph No. 5).

Photograph No. 1

Overflow or Bypass Channel looking upstream from the R446 bridge crossing



Photograph No. 2

Main R446 Bridge Crossing along the main channel looking upstream from the multi-arched stone bridge crossing shown in Photograph No. 3

Note : Full span of bridge available for flow and the water main located on the downstream face does not impede flows.

Photograph No. 3
Bridge crossing of Bypass Channel looking upstream towards the channel shown in Photograph No. 1

Note : Unlike the Main R446 Bridge crossing, this structure has a central pier/support which reduces the overall effectiveness of the bridge.

The water main is located on the downstream face of the bridge and does not impede flows.

Photograph No. 4

Muli-arched Stone Bridge looking downstream from the main R446 bridge Crossing shown in Photograph No. 2

Note : Low Flows generally restricted to the main arches on the right of the photo. Only in times of high flows are the arches on the left utilised due to high bank levels.

Photo No. 5
Railway Bridge looking downstream through the stone arch.

Note : Water marks on the bridge abutments indicate that the full capacity (arch height) of this bridge is not hydraulically used.

1.2 ZONE 2 – RAHASANE TURLOUGH

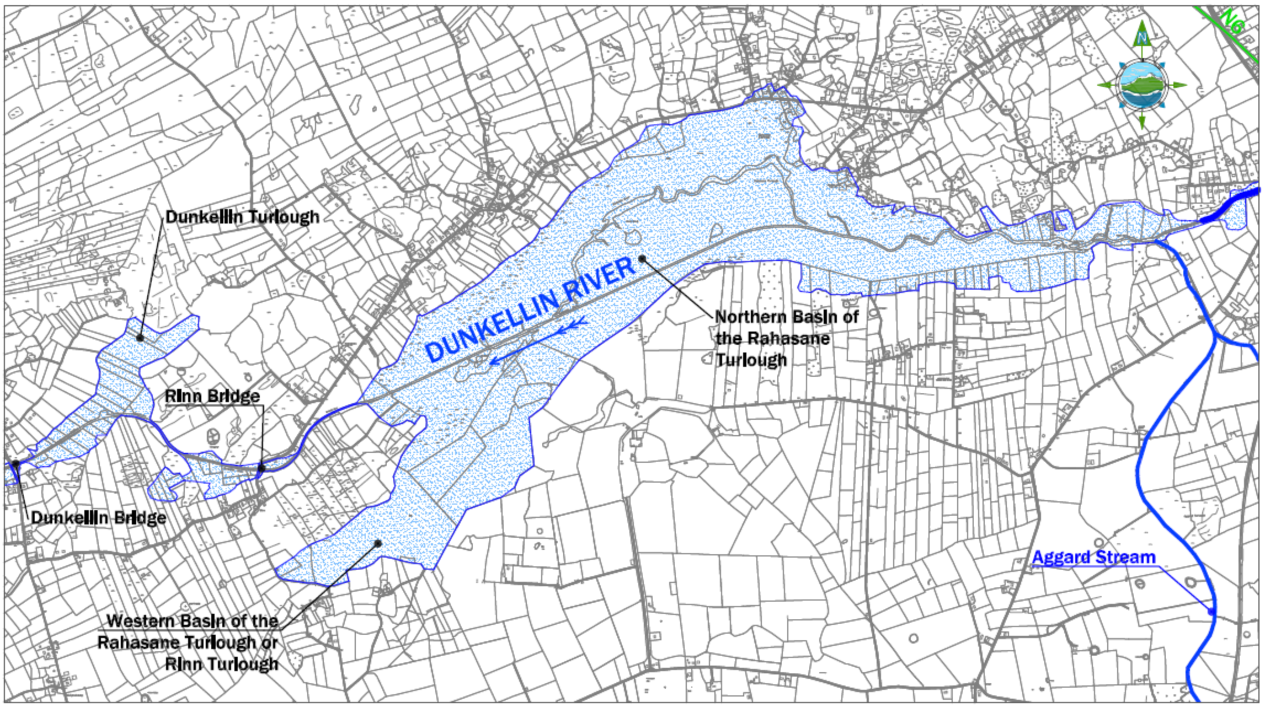
Water passing downstream of Craughwell Village, flows in a westerly direction for a distance of approximately 1km, where the Craughwell River and Aggard Stream combine to form the Dunkellin River.

During low flow conditions, surface water flows are restricted to the main Dunkellin River, which, following an Arterial Drainage Scheme in the 1850's, can be described as being "canalised" for a significant portion of its length. Along this particular stretch of the Dunkellin, the gradient of the channel bed is relatively flat, approximately 1 in 3,000.

During low flows, the channel varies in width from 10m to 30m. However, during periods of high flow, the Dunkellin River overflows its banks and floods the adjoining lands to form the Rahasane Turlough cSAC. The Rahasane Turlough cSAC is considered to be one of the largest turloughs in Europe and is of particular significance in an ecological context in that it is "one of only two large turloughs which still function naturally" (Site 000322 – Site Synopsis). The Rahasane Turlough cSAC is a rare habitat type of major conservation importance. This habitat type (turloughs) is listed in Annex 1 of the Habitats Directive.

The Rahasane Turlough (circa 4km in length) lies in gently undulating land and consists of two basins which are connected at times of flood but separated as the waters decline (Drew & Daly, 1996). These basins are detailed in Figure 1-5.

Figure 1-5 – Zone 2 Rahasane, Rinn & Dunkellin Turlough Complex



The larger of these, the northern basin, is described as the Rahasane Turlough proper. The Rahasane Turlough was formerly the natural sink of the Dunkellin River, but now an artificial channel takes some of the water further downstream. Water escapes the artificial channel to flood the northern basin where it flows into an active swallow hole system (NPWS, Site : 000322 - Site Synopsis).

The second of these basins, the western basin, known as the Rinn Turlough, is orientated north-south and is connected to the main Rahasane Turlough by a raised channel (circa 0.5m above the floor of the Rahasane Turlough). This Rinn Turlough is an overspill basin to the main turlough (Drew, 1986).

During flood conditions the width of the "Dunkellin River", or the flood plain, increases quite significantly, as can be seen in Photograph No. 6.

In a number of locations along Rahasane Turlough cSAC, the flood plain can be greater than 1km wide and, at its highest levels, can extend to cover an area of over 300ha.

Photograph No. 6
Rahasane Turlough

Taken in November 2009 looking northwards

The Rinn Turlough (Western Basin) is in the foreground.

The Rahasane Turlough (Northern Basin) is shown in the upper portions of the image.

Typical bed levels of the channel within the Rahasane Turlough cSAC are of the order of 13.0mOD Malin Head (TOBIN Topographical Survey 2010) with other localised depressions, or sinkholes, having levels of 11.0m OD Malin Head (Drew 1986).

Downstream of the Rahasane Turlough cSAC, flow is westerly toward Rinn Bridge, through a well defined canalised channel, measuring up to 3.3m in depth, and 15 to 20m in width. The section of channel downstream of the turlough is shown in Photograph No. 7. This section of the channel is formed in a rock cut, for a significant portion of its length, and the gradient of the channel bed is typically 1 in 200.

Photograph No. 7
Dunkellin River looking upstream from Rinn Bridge

1.3 ZONE 3 – RINN BRIDGE TO KILCOLGAN

The main channel exiting the Rahasane Turlough (Photograph No. 7) and the Rinn Bridge (Photograph No. 8), which is located approximately 800m downstream of the turlough, are the main downstream features impacting on the hydraulic control of the river.

Downstream of the Rinn Bridge, and during low flow conditions, surface water flows are restricted to the main Dunkellin River, which again, following the Arterial Drainage Scheme completed in the 1850's, can be described as being "canalised" for a significant portion of its length. During these low flows, this particular stretch of the river varies in width from 10m to 15m and, the gradient of the channel bed is approximately 1 in 300.

Photograph No. 8
Rinn Bridge taken from the upstream left bank

Note the central pier dividing the two spans

The bed level at this structure and the upstream channel control the normal flood levels in the Rahasane Turlough.

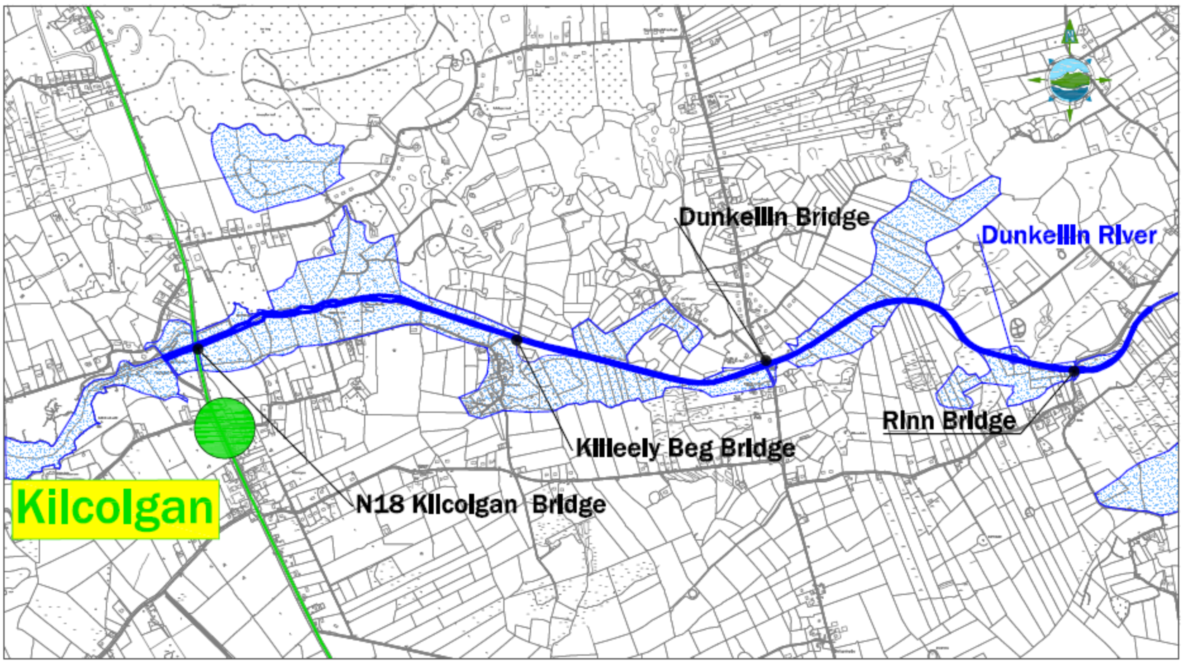


Figure 1-6 – Zone 3 Rinn Bridge to Kilcolgan

During high flows, the Dunkellin River also overtops its banks approximately 750m downstream of the Rinn Bridge and flood waters enter the Dunkellin Turlough as shown in Photograph No. 9.

Photograph No. 9
Dunkellin Turlough

Facing upstream with the Dunkellin Bridge in the centre of the image with a cluster of houses on each of the right and left banks

Photograph No. 10
Upstream face of the Dunkellin Bridge showing the main arch and flood eyes on the left bank

Low Flows at this location are restricted to the main channel and stone arch visible on the right of the photograph.

High flows overtop the channel and pass under the roadway via the three visible (smaller) arches.
However, restrictions, such as the trailer and piles of stone reduce the effectiveness of these flood eyes.

Downstream of the Dunkellin Bridge, the Dunkellin River continues for a further 2.5km to the sea via the Killeely Beg Bridge, the Kilcolgan Road (N18) Bridge and a local road bridge (stone arch). The lands and main channel within the vicinity of the Kilcolgan Road Bridge are tidal. Downstream of Dunkellin Bridge, the Dunkellin River continues to follow a well defined canalised channel, with gradients of between 1 in 300, and widths ranging from 10 to 30m, until it reaches the sea at Kilcolgan.

1.4 AGGARD STREAM

The Aggard Stream, as shown in Figure 1-7, discharges into the main Dunkellin channel at the confluence of the Craughwell and Dunkellin rivers approximately 1km downstream of Craughwell Village. The stream rises in the townland of Cregaclare, where water entering the channel, via surface contributions and ground water springs, flows in a northerly direction for a distance of approximately 4km in the townland of Monksfield. At this location, the channel discharges into the Monksfield River which, after a further 3.5km, enters the Aggard Stream. The channel flows almost parallel to the western railway corridor and crosses this railway at three locations.

Unlike the Dunkellin River, there are no designated sites (cSAC's, NHA's or SPA's) along the route of the Aggard Stream and Monksfield River.

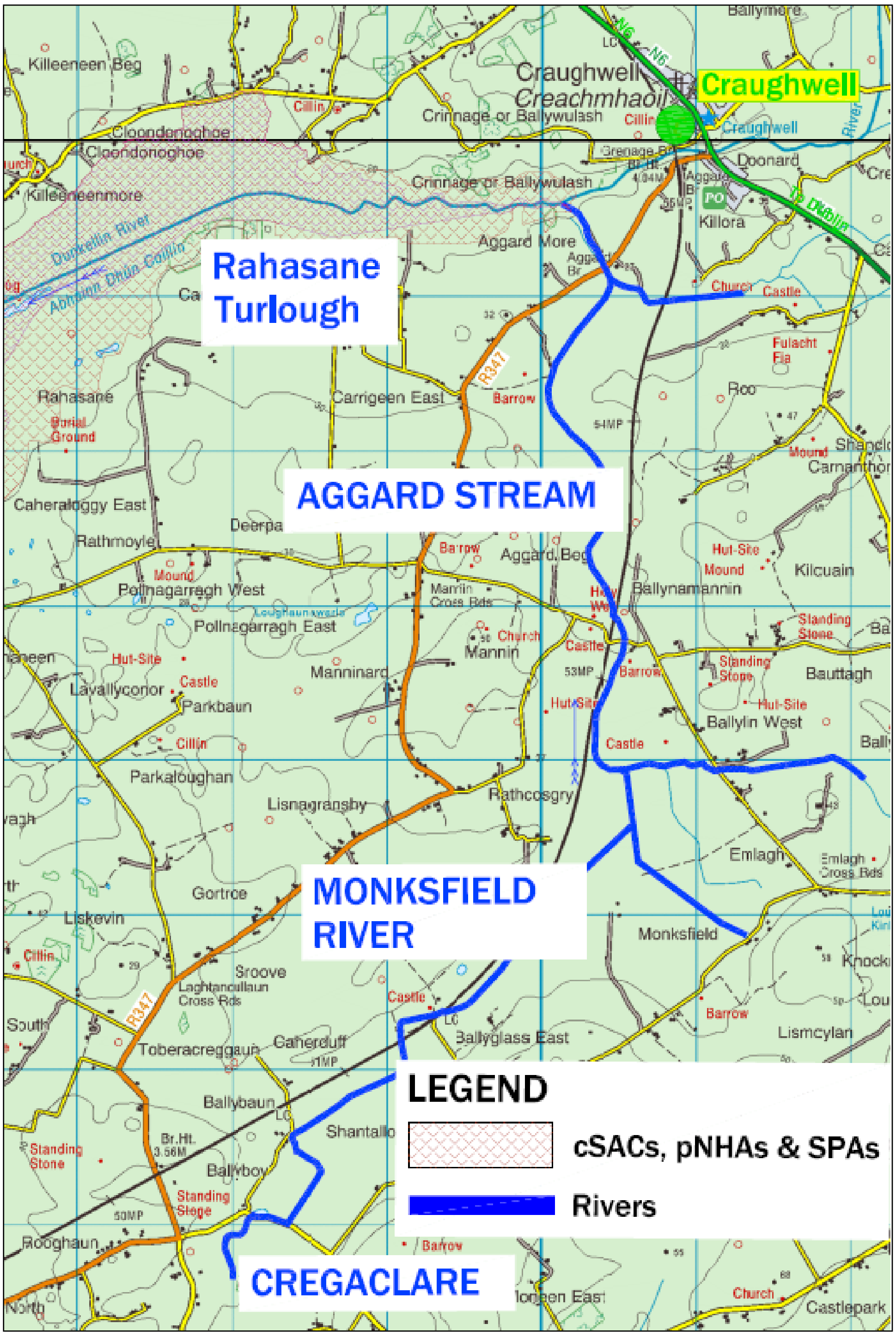


Figure 1-7 – Aggard Stream & Monksfield River

The bed profile and right/left bank levels along the Aggard Stream and Monksfield River from the townland of Cregaclare to the Dunkellin River are shown in Figure 1-8.

Along this channel, the bed profile ranges from a level of 32.5mOD (Malin Head) in its upper reaches, in the townland of Cregaclare, to 16.6mOD at the confluence with the Dunkellin River approximately 1km downstream of Craughwell.

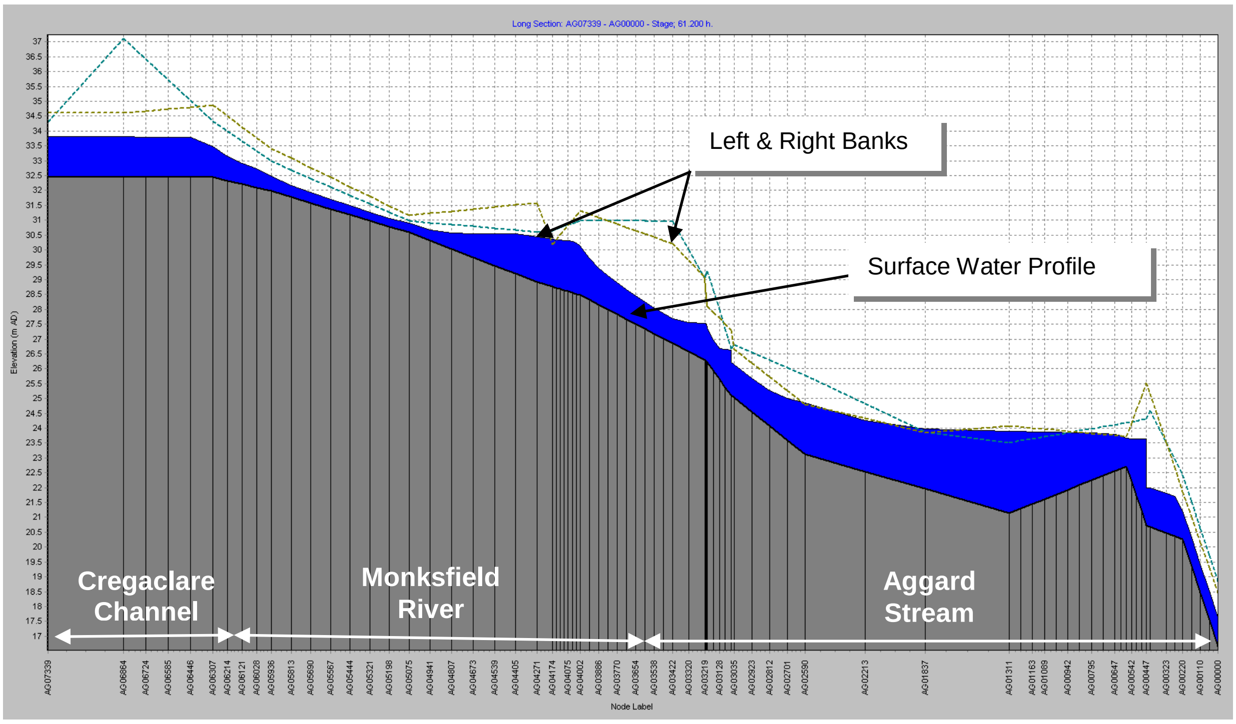


Figure 1-8 – Long Section of the Aggard Stream

The base width and side slopes of the Monksfield River and Aggard Stream are quite variable throughout its length.

In its upper reaches, along the Cregaclare Channel, the width of the stream is relatively narrow with some sections being 2.0 to 2.5m wide where the water depth is also quite shallow and stagnant as a result of the very flat gradient in bed level.

Along this stretch of the channel, field boundaries and local access crossings, as shown in Photographs 11 and 12, also impede the flow in the channel.

Photograph No. 11
Typical Boundary Crossing along the Aggard Stream in Cregaclare

Note : boundary wall traverses the channel without any pipework crossing to improve conveyance

Photograph No. 12
Typical Field Crossing along the Aggard Stream in Cregaclare

Dense weedy growth is also a significant feature of the upper reaches of this channel

Downstream of the Cregaclare Channel, in the townland of Ballyglass and Monksfield, the channel width becomes more pronounced and is typically 3.0 to 5.0m. The bed profile also steepens to a gradient of approximately 1 in 500. Along this stretch of the Monksfield River, the hydraulic control features are also more defined with concrete culverts and stone arch bridges used to traverse the railway line.

2 OVERALL DESIGN PHILOSOPHY

2.1 NEED FOR THE PROPOSED SCHEME

One of the most recent, and prior to November 2009, the highest recorded flooding event on the Dunkellin River, recorded by the gauging station in Craughwell (Station No. 29007), took place on the 10th of January 2005.

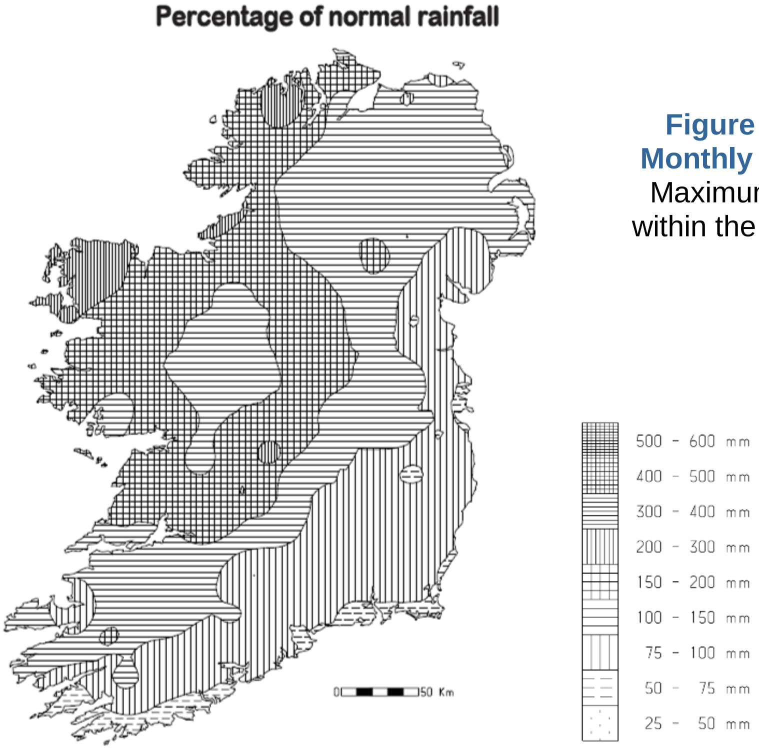


Figure 2-1 Extract from Met Eireann Monthly Weather Bulletin January 2005
Maximum Recorded Percentage Rainfall within the Dunkellin catchment ranged from 100% to 150%

The maximum level recorded on 10th January 2005 corresponded to a staff gauge reading of 2.83m, or a water level of 21.53mOD Malin Head.

Digital records, along with aerial photography for this flooding event, were documented by the OPW and the following photographs highlight some of the flooded lands, to the west of Craughwell, a number of days after the event has passed.

Photograph No. 13 January 2005 Event looking downstream to the west of Craughwell towards the Rahasane Turlough on 12th Jan 2005

Photograph No. 14
January 2005 Event looking upstream towards Craughwell from the Rahasane Turlough on 12th Jan 2005

The width of the flood at this location was approximately 375m

A number of weather events occurred across Ireland, during the first three weeks of November 2009, which resulted in record rainfall and high water levels being recorded in many parts of Galway. The flooding which occurred at Craughwell, and downstream at Rinn Bridge, Dunkellin Bridge and Killeely Beg Bridge, was as a result of several days of persistent rain over the country which, when combined with high winter water tables, resulted in water levels which exceeded those normally encountered in many rivers during the same period.

During November 2009, the weather station at NUI Galway recorded a monthly total of 329.4mm of rain, which represents 286% of the average November rainfall for the period 1961 to 1990. Leading up to this flooding, a peak daily rainfall of 60.8mm was recorded at NUI Galway on the 17th November 2009.

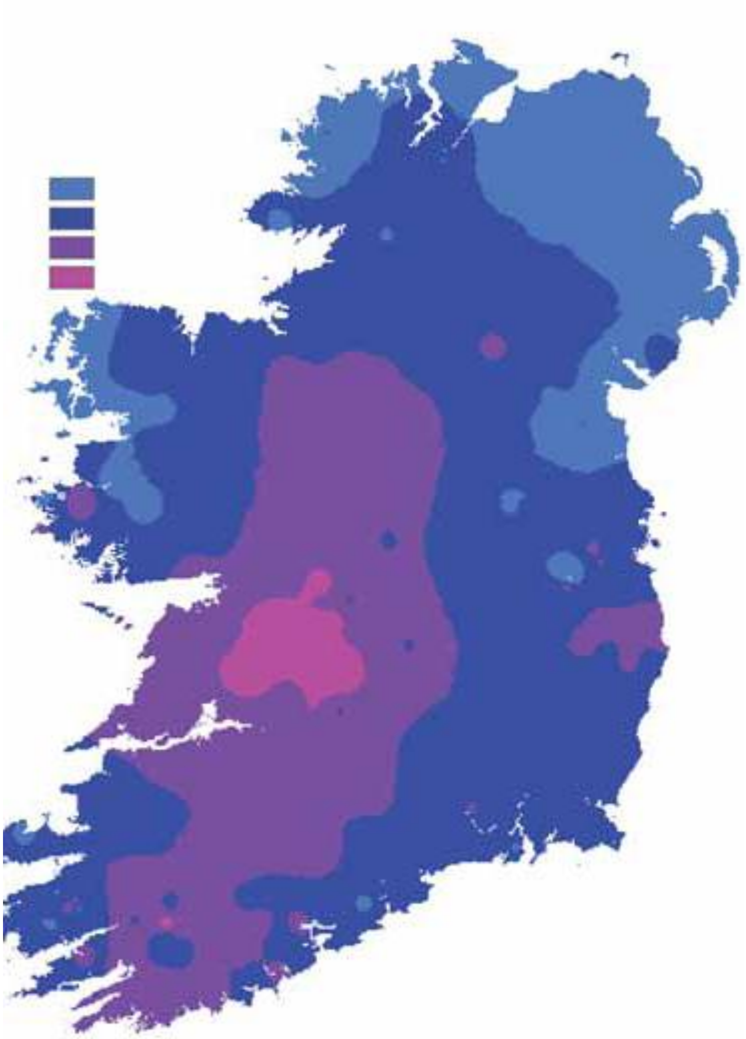


Figure 2-2 Extract from Met Eireann Monthly Weather Bulletin November 2009

150 to 200% of Normal Rainfall
200 to 250% of Normal Rainfall
250 to 300% of Normal Rainfall
>300% of Normal Rainfall

During the period 17th to 24th November 2009, daily rainfall amounts on Wednesday 19th were recorded as 26.7mm and 29.4mm at the Shannon and Claremorris Weather Stations, respectively, but based on the rainfall data recorded at NUI Galway, it is clear that localised heavier rainfalls occurred in the Galway Area. This peak rainfall was followed by peak flood levels :

d. upstream of Craughwell village along the R349 (Loughrea to Athenry Road) at approximately midday on Thursday 20th November,
e. at the Craughwell River/R446 road crossing during Thursday afternoon (road closed in afternoon resulting in significant traffic disruption), and
f. downstream of Craughwell at Rahasane Turlough during Friday 21st November.

The following photography, taken by the OPW & Central Fisheries Board, during the period Thursday 20th to Saturday 22nd November 2009, shows the extent of flooding which occurred in late November 2009.

Photograph No. 15 Flooding in Craughwell at the Main R446 crossing on 20th Nov 2009

The extent of dwellings flooded, or at risk from flooding, in the village is evident .

Turbulent flow crossing the R446 is also evident in the lower left foreground where both the bypass (lower left) and main N6 bridge crossing (centre) were overtopped.

The R446 (formerly N6) Road was closed for 4 days during this event.

Photograph No. 16 Rahasane Turlough downstream of Craughwell on 23rd Nov 2009

The Kilcolgan Road with ribbon development is visible in the upper portions of the photograph. This road was closed for 10 days during this event and properties were flooded along this stretch of the Dunkellin River

Photograph No. 18
Flooding at Dunkellin Bridge on 23rd Nov 2009

View facing upstream with the Dunkellin Bridge in the centre of the image with a cluster of houses on each of the right and left banks

The Dunkellin Turlough is also visible in the background

Photograph No. 17
Flooding in townland of Killeely Beg on 23rd Nov 2009

The "canalised" Dunkellin River is a straight section of channel in this location. The channel breaks its banks and follows the natural contours of the adjacent lands and ultimately bypasses the Killeely Beg Bridge in the centre of the photo (surrounded by trees).

Note : extent of dwellings flooded, or at risk from flooding, in this location

Following a review of aerial photography of the November 2009 event and by establishing an account of local anecdotal evidence, the estimated flood plain during the November 2009 event can be established. This flood plain is shown in Figure 2-3.

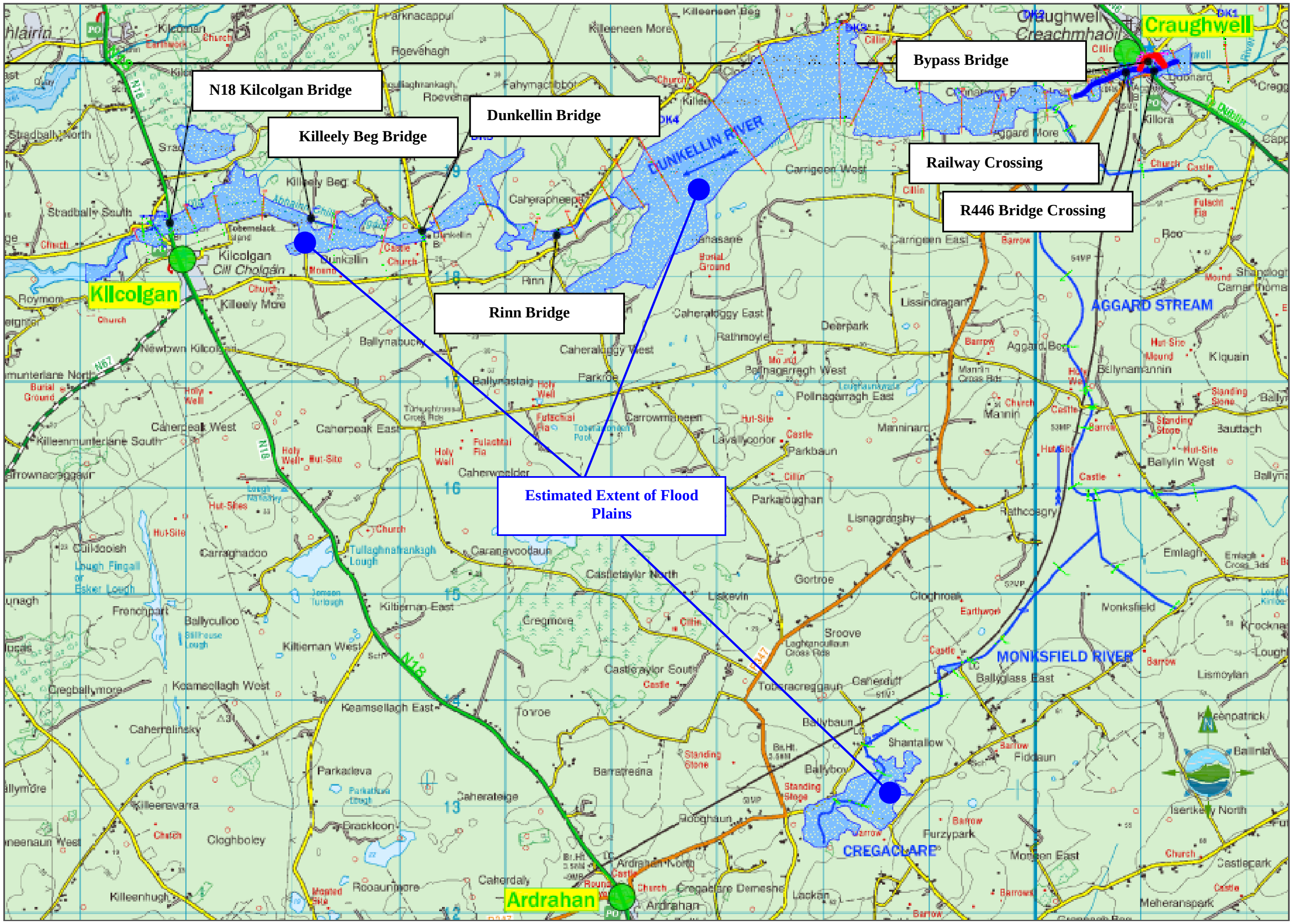


Figure 2-3 – Estimated Flood Plains along the Dunkellin and Aggard Stream based on Photography of the Nov 09 Event and local anecdotal evidence

From the recorded hydrographs of the event, aerial photography, measured wrack levels, direct observation from local residents and the estimated flood plain contained in Figure 2-3 it can be observed that:

1. Flooding upstream of Craughwell along the R349, (Athenry to Loughrea Road) north of Craughwell, occurred in advance of the flooding on the R446 within the village.

2. The R446 road bridges (2 No. flat deck concrete structures and 1 No. old stone arched bridge) are significant hydraulic restrictions, as both the main bridge and the additional “bypass/overflow” were overtopped.

3. The railway bridge, with a smaller effective cross sectional area, is also a significant restriction and an influencing factor on the upstream flooding within Craughwell.

4. The main channel downstream of the railway bridge and upstream of the Aggard/Dunkellin confluence, despite its steep bed gradient is also causing a restriction on flow.

5. The channel exiting the Rahasane Turlough cSAC and the Rinn Bridge have insufficient capacity to cater for this event.

6. The Dunkellin Bridge and Killeely Beg Bridge, and the channel upstream and downstream of these structures, also have insufficient capacity to cater for this event.

These observations, further analysis of the recorded river flow data, possible flood alleviation measures, and the mathematical modelling of these measures are discussed later in this section.

The following aerial photography details a number of locations where dwellings and commercial properties were flooded during the November 2009 event.

Photograph No. 19 Craughwell Village

Three dwellings were flooded in Craughwell, located in the centre of the photo and to the left of the R446 roadway. The R446 was also closed for 4 days during this event.

Two commercial properties were also flooded including the underground car park of the new development in the top left hand portion of the image.

Whilst the dwelling on the right of the photo was not flooded the surrounding gardens were inundated with flood waters.

Photograph No. 20 Rahasane Turlough

A number of properties were flooded at a number of locations along the northern shores of the Rahasane Turlough.

Whilst this image was taken after the flood had subsided, the threat to the Kilcolgan road is evident in this image.

Photograph No. 21 Killeely Beg Townland

A total of five dwellings were threatened by flood waters in the townland of Killeely Beg when the Dunkellin River broke its left bank and travelled along what appears to be the natural contour of an old channel.

2.2 FLOOD RELIEF DESIGN STANDARDS

It is generally accepted by the Office of Public Works (OPW) and Local Authorities that, where possible, a flood relief scheme should accommodate the 100-year design flood.

A significant amount of Hydrometric Data was received from the OPW for several hydrometric gauges within the study area. Figure 2-4 shows the location of the OPW hydrometric stations used in this study. The data consists of:

- Annual maximum series of recorded water levels and estimated flows for the Data Logger Stations, on the Dunkellin Catchment listed above, for the period of records dating from the commissioning of the hydrometric station to January 2010.

- Instantaneous 15 minute water level and flow data for the flood period 01/11/2009 to 15/01/2010 for each hydrometric station listed above, with the exception of Rahasane Turlough Station where the data logger was inundated during the November 2009 flooding event resulting in no data being available beyond 07:30hrs on the 19/11/09.

- Station rating equations and rating periods

The Environmental Protection Agency, Hydrometric Office, Castlebar has also provided data of measured flow for the November 2009 flooding event at Craughwell Station 29007, where measurements were carried out on the 21/11/2009 one day after the peak of that flood event.

The OPW have also undertaken a review of measurement records of the Hydrometric Station at Craughwell (Station No. 29007) and in doing so have considered the quality assurance and accuracy of data presented for this gauge. The mathematical review of the recorded data using both the EV Type I and EV Type II extreme value distributions have shown that due to:

a) partial blockages of the old Craughwell bridge
b) debris blockages
c) reduced conveyance (caused by gravel movements, weed growth, over hanging woody vegetation
d) bridge skew, and
e) bypassing flow (bypass channel)

careful consideration of the return period estimates is required.

In completing the review of the hydrometric data the OPW have estimated that the November 2009 event, at a flow of 84.8 m^3/sec has a return period of 122 years.

The estimated return period floods have also been established by the OPW. These are presented in Table 2-1.

Table 2-1 – Summary

Flow (m3/s)	Return Period (years)	EV1	EV2
28.6	1	-	-
34.0	2	0.37	-
42.0	5	1.50	1.72
49.3	10	2.25	2.77
60.5	25	3.20	4.32
70.3	50	3.90	5.66
81.4	100	4.60	7.16
94.0	200	5.30	8.86
98.4	250	5.52	9.45
113.2	500	6.21	11.45
130.0	1,000	6.91	13.71

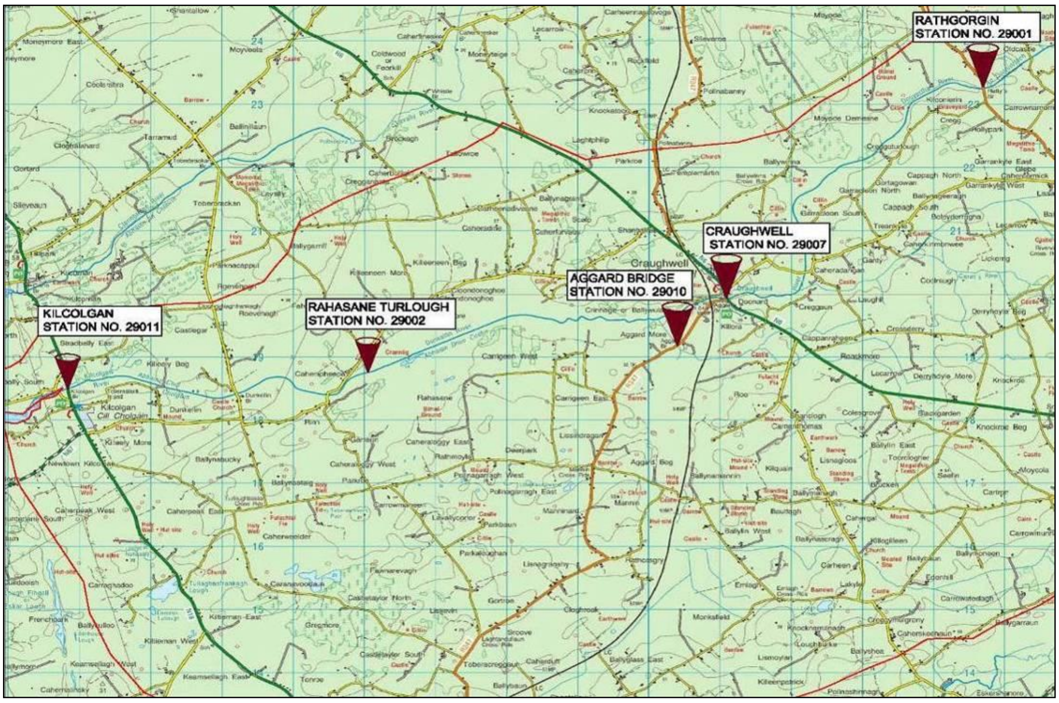


Figure 2-4 – Location of Hydrometric Stations in Dunkellin Catchment

2.3 CLIMATE CHANGE & FUTURE FLOW SCENARIOS

Two broad approaches are considered when implementing a proposed flood relief scheme.

These are:

(1) Design based on historic records

This approach considers historic flood and water level data and while climate change impacts are investigated, no allowance is made for climate change in relevant design parameters.

(2) Design for Climate Change

Designing for climate change is an approach where the level of proposed defences or the size of the proposed channel works are such that future climate change predictions are considered.

Whilst the design of the proposed works along this stretch of the Dunkellin River takes into account a series of environmental river enhancement works, the proposed approach to implementing the Dunkellin & Aggard Flood Relief Scheme is to design for climate change.

The document entitled *"Assessment of Potential Future Scenarios for Flood Risk Management"* and published by the OPW in August 2009 has been reviewed as part of this planning stage design.

This document states that :

"To provide an adequate understanding of the potential implications of the predicted impacts of climate change and other future changes, with due consideration of the significant uncertainty associated with such predictions, the OPW recommends that a minimum of two potential future scenarios are considered."

The two minimum scenarios are referred to as the :

"Mid-Range Future Scenario (MRFS) which it is intended to represent a 'likely' future scenario, based on the wide range of predictions available and with the allowances for increased flow, sea level rise, etc. within the bounds of widely accepted projections."

And

"High-End Future Scenario (HEFS), is intended to represent a more extreme potential future scenario, but one that is nonetheless not significantly outside the range of accepted predictions available, and with the allowances for increased flow, sea level rise, etc. at the upper the bounds of widely accepted projections."

The allowances, in terms of numerical values, for future changes which should typically be used for each of these scenarios, are set out in Table 2-2.

Table 2-2 – Allowances for Future Scenarios (100 year time horizon)

	Mid-Range Future Scenario MRFS	High-End Future Scenario HEFS
Extreme Rainfall Depths	+ 20%	+ 30%
Flood Flows	+ 20%	+ 30%
Mean Sea Level Rise	+ 500 mm	+ 1000 mm

In developing the mathematical model for the study area, the Mid Range Future Scenario (MRFS) has been adopted to establish the possible impact that the increases may have on the recommended flood alleviation measures.

The estimated 100 year return flow at each gauging station, the allowance for future scenarios and the November 2009 event are summarised in Table 2-3.

Table 2-3 – Estimated Design Flows used in the development of the Proposed Flood Relief Works

	Craughwell 29007	Aggard Stream 29010
Estimated 100yr Return Flow	81.4 m³/s	18.00m³/s
Allowance for Mid-Range Future Scenario	16.28 m³/s	3.6 m³/s
Estimated Future Scenario	**97.68 m³/s**	**21.6m³/s**
Estimated Peak Flow November 2009 Event	84.8 m³/s	21.46 m³/s

2.4 HYDRAULIC MODELLING AND TESTING OF THE PROPOSED FLOOD RELIEF SCHEME

2.4.1 Hydraulic Modelling

The modelling software used for the purposes of this study is HEC-Ras, a 1 dimensional (1D) hydraulic model. The model is based on cross-sections of the water course, surveyed as part of this study and supplemented, where required on a limited basis, with additional cross sectional information from the original OPW Arterial Design which was completed in the mid 1950s. All of the topographical information, particularly level information, is based on the Malin Head datum. The extent of the survey cross sections used in the hydraulic model were determined by analysing the November 2009 flood event and selecting critical locations where flood level information was available from automatic gauging stations and anecdotal evidence from local representatives.

The modelled reach of the Dunkellin River is approximately 10.8km long, and starts approximately 780m upstream of the Main N6 bridge Crossing in Craughwell.

The modelled reach starts with an elevation of approximately 24 m.OD Malin, in Craughwell and ends with an elevation of 0.8 m.OD Malin, in Kilcolgan.

The downstream extent of the model is approximately 125m downstream from the N18 Bridge Crossing at Kilcolgan and this downstream boundary is in a tidal reach. The downstream boundary used in the hydraulic model is a high tide of 2.9mOD.

A number of assumptions have been made with regard to the model build for this study. These are summarised as follows:

- Surface features such as walls, buildings, isolated trees, fences and hedges have not been included in the model. These features may affect flows along the floodplain that are not accounted for in the model.
- Default weir, culvert and bridge loss coefficients have been used.
- All structures included in the model have been assumed to be in good condition and will withstand a flood event without damage.
- The model used in this study is a one-dimensional mathematical model, which has some limitations.
- Roughness co-efficients were based on Manning's 'n' values as derived from Chow (Open-Channel Hydraulics, McGraw-Hill, 1959).
- The hydraulic model was calibrated using the November 2009 event and the depth of water encountered along the river and through the Rahasane Turlough. This event was recorded at the Craughwell & Aggard gauging stations and has also been estimated to be greater than a 1% AEP (i.e., 1 in 100 year return period) event.
- The base model used the flow recorded at the Craughwell gauge as a Q-T (flow-time) input, and compared the model's calculated flow with the recorded flood depths along the channel reaches. The flow recorded at Aggard Bridge was also included in the model build and calibration.

3 DETAILED DESCRIPTION OF THE PROPOSED SCHEME

3.1 INTRODUCTION

Initially, three broad modelling designs or Strategic Schemes were examined in the development of the preferred flood relief scheme and following consultation with key environmental stakeholders a fourth and final "Preferred Scheme" was developed.

The first scheme examined a package of coherent, effective works, which concentrated on channel improvements and reconstruction of those structures whose removal would be essential in an effective scheme of works. This first scheme known as "Strategic Scheme No 1" examined the impact of works associated with :

1. deepening particular lengths of the channel between bridge structures,
2. the use of flood eyes or bypass/over culverts at the Dunkellin Bridge and Rinn Bridge,
3. removal of the old multi-arched stone bridge crossing (pedestrian bridge) in Craughwell, and
4. deepening of the bed level at the Railway Crossing and R446 (formerly N6) bridge in Craughwell Village.

The second scheme known as "Strategic Scheme No. 2" examined the incremental benefit of more extensive bridge replacement, including :

1. the impact of channel widening, in lieu of deepening as examined under Strategic Scheme No.1,
2. the complete replacement of the Killeely Beg and Dunkellin Bridges,
3. the use of bypass culverts at the Railway Bridge in Craughwell,
4. removal of the old multi-arched stone bridge crossing (pedestrian bridge) in Craughwell, and
5. the complete replacement of the bridges on the R446 in Craughwell with larger span structures.

The third scheme known as "Strategic Scheme No. 3" examined the benefit of more extensive main channel deepening (Dunkellin River) in Craughwell and the deepening of the bypass channel in Craughwell, including :

1. the impact of channel widening in the lower reaches of the Dunkellin River at Kilcolgan,
2. the complete replacement of the Killeely Beg Bridge,
3. the provision of flood embankments between Killeely Beg and Dunkellin Bridge
4. the provision of two large bypass culverts at the Dunkellin Bridge,
5. the use of three bypass culverts at Rinn Bridge downstream of the Rahasane Turlough cSAC,
6. channel works downstream of the Rahasane Turlough and upstream of Rinn Bridge,
7. deepening of the main channel at the Railway Bridge in Craughwell, the deepening of the main channel in Craughwell including underpinning of the railway bridge in Craughwell,
8. the deepening of the main channel in Craughwell to facilitate retention, by underpinning, of the old multi-arched stone bridge crossing (pedestrian bridge) in Craughwell, and
9. the deepening of the main channel in Craughwell to facilitate retention, by underpinning, of the bridge crossing on the R446 in Craughwell, and
10. the deepening of the bypass channel in Craughwell to facilitate retention, by underpinning, of the bridge crossing on the R446 in Craughwell.

The fourth scheme known as "Strategic Scheme No. 4" or ultimately the proposed "Preferred Scheme" examined the benefit of the main channel deepening in Craughwell, as detailed in Strategic Scheme No. 3, but reduced the extent of the proposed excavations between the Rahasane Turlough and Rinn Bridge limiting works to out of channel maintenance downstream of the Rahasane Turlough to Rinn Bridge (i.e., trimming back of terrestrial vegetation such as trees and low hanging branches and removal of encroaching vegetation such as brambles and scrub) and bypassing of the Rinn Bridge. The proposed works downstream of the turlough (at Rinn Bridge) have been designed so as to limit the predicted impact on water levels within the Rahasane Turlough.

The hydraulic models of the Strategic Schemes, combined with early public and stakeholder consultation, consultation with Galway County Council and the OPW, indicated that the particular selection of flood alleviation measures, included in "Strategic Scheme No. 4" would produce the "Preferred Scheme".

The proposed works strike a delicate balance at Rahasane Turlough cSAC. Extreme floods would be passed through the Turlough where possible, by limited excavations downstream of the turlough and adaptations at Rinn Bridge, which would deliberately minimise the predicted changes in water levels within the turlough so to maintain the ecologically critical water level range.

The impact of this change in hydraulic control, downstream of the turlough, and the predicted change on normal water depth levels, means that the full benefits of flood relief, expected under "*Strategic Scheme No. 3"* cannot be achieved. The model predicts that the November 2009 flood level of 18.9mOD, within the Rahasane Turlough, will not be reduced and further alternative and localised flood protection measures (subject to consultation with local residents) may be required along the northern shore of the turlough.

The proposed engineering measures, working from the downstream location at the Kilcolgan Bridge on the N18, included in Strategic Scheme No. 4 or the ***"Preferred Scheme"*** and as detailed in Table 3-1, can be summarised across three zones as follows:

Zone 3 – Rinn Bridge to Kilcolgan:

Works to be undertaken downstream of the Rahasane Turlough from the townland of Rinn to the N18 at Kilcolgan.

Zone 2 – Rahasane Turlough:

No works to be undertaken along/within the Rahasane Turlough.

Zone 1 – Craughwell Village:

Works to be undertaken from Craughwell Village to the confluence of the Aggard Stream.

In addition to the engineering measures detailed above, additional works will be undertaken within the river channel to aid the passage of fish up the river. This will involve the construction of river enhancement works. These works will be developed further at detailed design stage through consultation between the Design Team, the Inland Fisheries Ireland, Galway County Council, the OPW and other relevant authorities.

Table 3-1 – Summary of the proposed *"Preferred Scheme" in Zones 1, 2 &3*

Zone	Works item No.	Description of Location	Proposed Scheme
1	1	Main Channel (Craughwell Village)	The main channel shall be deepened from 17.85mOD (35m u/s of the road bridge in Craughwell) to 14.66 mOD (610m d/s of the railway bridge)
	2	R446 Bridge	The channel shall be deepened by approximately 0.6m at the R446 Road Bridge (underpinning of the bridge will be required)
	3	Masonry Arch Pedestrian Bridge	The channel shall be deepened by approximately 0.6m at each arch (underpinning of all arches will be required).
	4	Bypass Channel (Craughwell Village)	The channel shall be graded from an u/s level of 18.5 to a d/s level of 18.0 mOD. (The bypass bridge will require underpinning to match proposed bed levels)
	5	Railway Bridge	The channel shall be deepened by up to 0.75m. (underpinning/scour protection of the railway bridge will be required)
2	6	Works at Rahasane Turlough	It is Not Proposed to Complete any Works within or adjacent to the main body of the Rahasane Turlough cSAC.
3	7	Channel Works at Rinn	A two stage channel typically 20m wide will be constructed from approximately 50m upstream of Rinn bridge to approximately 50m downstream of the bridge. Strictly out of channel maintenance works aimed at the removal of encroachment of terrestrial vegetation, removal of fallen/instream trees, with no dredging and no channelization/arterial drainage works. Terrestrial vegetation along the river banks would be managed (i.e. trimming back of brambles and scrub) rather than being removed.
	8	Works at Rinn Bridge	Three flood eyes will be provided each measuring 3.1m wide x 2.1m deep
	9	Channel Works beginning upstream of Dunkellin bridge to Kilcolgan Bridge	Maintenance works aimed at the removal of encroachment of terrestrial vegetation, removal of fallen/instream trees. Vegetation along the river banks would be managed (i.e. trimming back to 1.0m to 1.5m above high flood levels or top of bank) rather than being removed. Flood relief works will commence approximately 175m upstream of the Dunkellin bridge and consist of the construction of a two stage channel typically 20m wide.
	10	Works at Dunkellin Bridge	In conjunction with localised channel widening to facilitate the proposed bridge works (30m), the flood eyes shall be replaced with 2 new box culverts each measuring 13m wide x 2.3m deep
	11	Channel Works from Dunkellin Bridge to Killeely Beg Bridge	Two stage channel works continue from Dunkellin Bridge to Killeely Beg Bridge with a typical channel width of up to 20m.
	12	Works at Killeely Beg Bridge	In conjunction with localised channel widening to facilitate the proposed bridge works (14m), a new bridge shall be provided with an 18m span and a soffit level of 7.80 mOD.
	13	Salmon Counter	The salmon counter will be relocated to a position upstream of Kileely Beg bridge as part of the river enhancement works
	14	Channel Works from Killeely Beg Bridge to the N18 Bridge	Two stage channel works will continue from Killeely Beg to the N18 Bridge with a typical channel width of up to 20m. From a distance of 400m upstream of the N18 Bridge the two stage channel will be tapered back to match existing channel widths.
	15	Works at Kilcolgan & N18 Bridges	No Works Proposed

3.2 PROPOSED WORKS DOWNSTREAM OF THE RAHASANE TURLOUGH CSAC (ZONE 3)

3.2.1 Works Item No. 15 – Works At Kilcolgan Bridge

It is not proposed to undertaken any engineering measures at the Kilcolgan Bridge on the N18.

3.2.2 Works Item No. 14 – Channel Works from Killeely Beg Bridge to the N18 Bridge

The proposed works from upstream of the Kilcolgan Bridge at the N18 (Chainage 956m) to Killeely Beg Bridge (Chainage 1,529m) will consist of two-stage channel works whereby the top width of the channel will be increased from an average of 14m to a proposed average width of 34m. A 500m long embankment shall also be constructed on the left bank, from Killeely Beg Bridge with a maximum height of 3.0m above existing ground level. The proposed works will not involve excavation within the existing channel (in river works) and it is not proposed to alter the existing bed levels. This method of construction means that average annual flow can be contained within the existing channel and excavation can be undertaken along the bank with minimal interference to the water quality.

Maintenance works aimed at the removal of encroachment of terrestrial vegetation, removal of fallen trees and other obstacles will be undertaken along the river bank where flood relief works are not undertaken. Terrestrial vegetation along the river banks would be managed (i.e. trimming back to 1.0m to 1.5m above high flood levels) rather than being removed.

However, while it is proposed to undertake excavations along the left bank of the Dunkellin River, and that these works can be undertaken in dry bank conditions, such excavations have the potential to impact on the water quality of the river whereby silt may enter the river. This risk can be reduced or eliminated by operating in the dry conditions along the river bank.

Figure 3-1 provides an illustration of a typical cross section of the works to be undertaken along this section of the Dunkellin River.

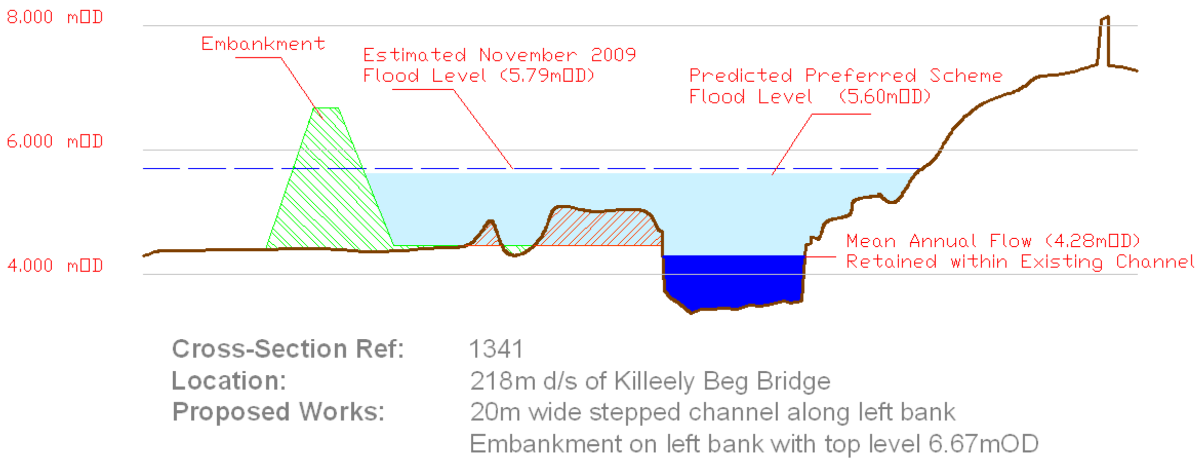


Figure 3-1 – Typical Cross Sectional Detail downstream of Killeely Beg Bridge

3.2.3 Works Item No. 13 – Relocation of the existing Salmon Counter

The existing salmon counter, shown in Photographs No. 22 and 23, is impacting on the high level water surface profile in the vicinity of Killeely Beg Bridge and is resulting in high water levels upstream of the bridge. Following consultation with the Inland Fisheries Ireland and other local parties, it is proposed to relocate this structure to a location upstream of the Killeely Beg Bridge. The proposed structure will be similar in all aspects to the existing concrete structure.

Photographs No. 22 and 23
Existing Salmon Counter

It is proposed to replicate the existing structure at a location upstream of the Killeely Beg Bridge. Note : change in depth of flow at this structure

The proposed salmon counter will be constructed in cast-insitu concrete and this will be undertaken in two halves, utilising cofferdam type construction whereby flow can be restricted to one half of the channel width allowing the civil engineering works to be undertaken in the dry conditions of the other half. This method of construction reduces the risk of wet concrete and other construction debris entering the river.

3.2.4 Works Item No. 12 – Works at Killeely Beg Bridge

Engineering works in the townland of Killeely Beg will include the complete replacement of the existing stone arched bridge. The existing bridge is approximately 8.2m wide and is a hydraulic constraint causing flooding upstream of the existing bridge.

It is proposed to replace this existing structure with a new bridge with a clear span of up to 18m and the proposed indicative bridge works are illustrated on Figure 3-2.

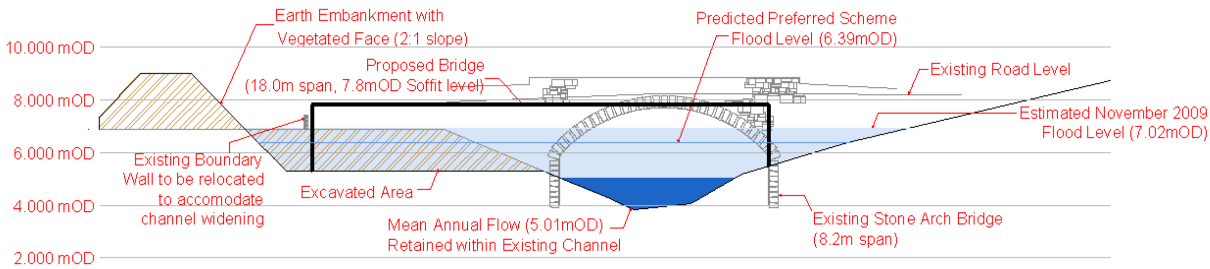


Figure 3-2 – Proposed Works at Killeely Beg Bridge

It is expected that the new bridge will be constructed from precast bridge beams resting on new concrete abutments on each river bank. It is also proposed to retain stone from the existing facades to construct the parapets of the proposed precast bridge.

The works will require the closure of the existing access road which is utilised for land access only and traffic disruption will be minimal. The proposed channel widening and bridge works will also require the realignment of the existing access road where suitable excavated material from the channel works can be utilised as fill material.

3.2.5 Works Item No. 11– Channel Works from Dunkellin Bridge to Killeely Beg Bridge

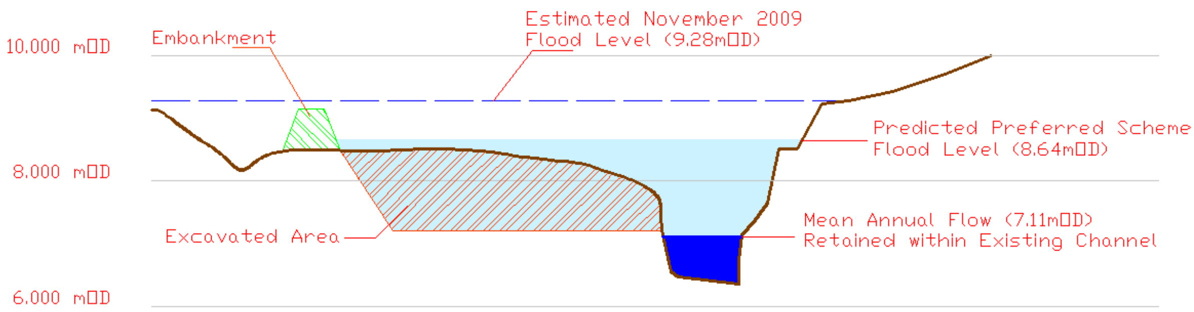
The proposed works from the Killeely Beg Bridge (Chainage 1,566m) to Dunkellin Bridge (Chainage 2,628m) will again consist of two-stage channel works whereby the top width of the channel will be increased from an average of 13m to a proposed width of 35m. The proposed works will not involve excavation within the existing channel (in river works) and it is not proposed to alter the existing bed levels. This method of construction again means that average annual flow can be contained within the existing channel and excavation can be undertaken along the bank with minimal interference to the water quality.

It is also proposed to construct an embankment on the left bank to a height above the predicted flood level. This flood embankment and two stage channel works will control and contain the extent of floodwater which had previously bypassed Killeely Beg Bridge (November 2009) and flooded numerous properties in Killeely Beg. It is proposed to use excavated material to form the embankment where possible.

However, while it is proposed to undertake excavations along the left bank of the Dunkellin River, and that these works can be undertaken in dry bank conditions, such excavations have the potential to impact on the water quality of the river whereby silt may enter the river. This risk can be reduced or eliminated by operating in the dry conditions along the river bank.

Maintenance works aimed at the removal of encroachment of terrestrial vegetation, removal of fallen trees and other obstacles will be undertaken along the river bank where flood relief works are not undertaken. Terrestrial vegetation along the river banks would be managed (i.e. trimming back to 1.0m to 1.5m above high flood levels) rather than being removed.

Figure 3-3 provides an illustration of a typical cross section of the works to be undertaken along this section of the Dunkellin River.



Cross-Section Ref: 2286 (Adjacent to DK31)
Location: 334m d/s of Dunkellin Bridge
Proposed Works: 20m wide stepped channel along left bank
Embankment on left bank with top level 9.14mOD

Figure 3-3 – Proposed Works Channel Works from Killeely Beg Bridge to Dunkellin Bridge

3.2.6 Works Item No. 12 – Works at the Dunkellin Bridge

Engineering works in the townland of Dunkellin will include the provision of bypass culverts to one side of the existing main stone arch. The existing structures at this location consist of a stone arched bridge spanning the main channel with five flood eyes located along the left bank of the channel. The existing flood eyes are insufficiently sized to cater for predicted flood flows and as such it is proposed to provide two new bridge structures each with a clear span of 13m and both located on the left bank. The construction of the proposed structures will require demolition of the existing flood eyes on the left bank and it is proposed to retain stone from the existing facades to construct the parapets of the proposed precast bridges.

The proposed indicative bridge works are illustrated on Figure 3-4.

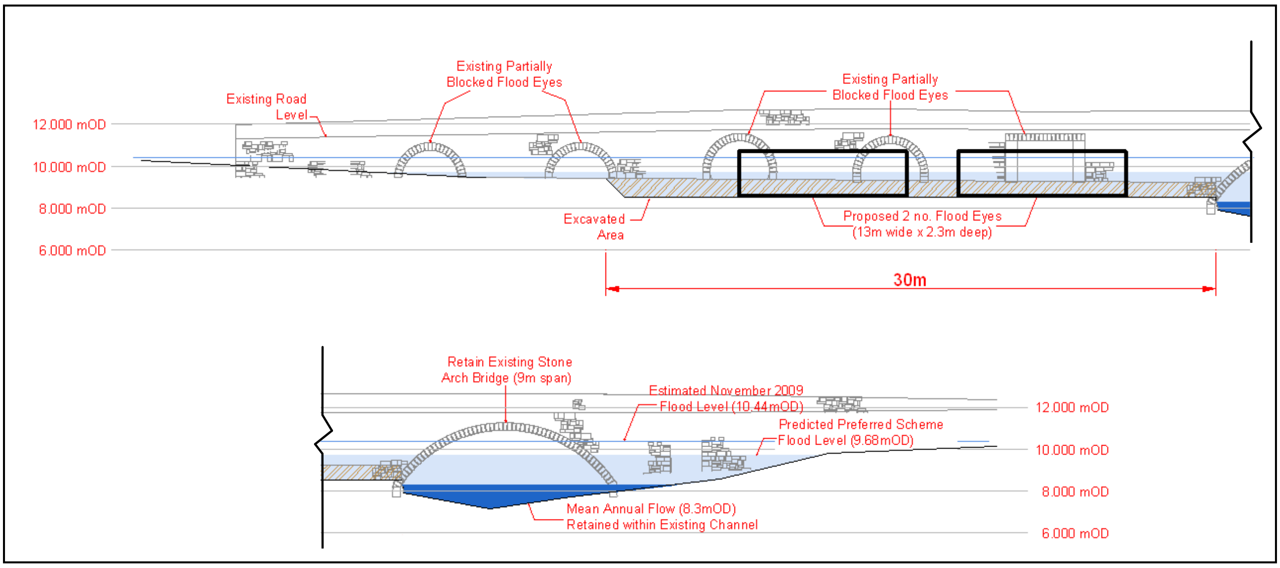


Figure 3-4 – Proposed Works at the Dunkellin Bridge

It is expected that the new bridge structures will be constructed from precast bridge beams resting on new concrete abutments.

The works will require the closure of the existing public road and therefore traffic disruption will be encountered. However road diversions can be put in place on the northern approaches at Roveagh and along the southern approaches at Madden's Forge with local access, to the northern and southern sides of the river, being maintained throughout the works.

3.2.7 Works Item No. 9 – Channel Works from the Dunkellin Bridge to Rinn Bridge

The proposed works from the Dunkellin Bridge (Chainage 2,634m) to Cross Section 3053 (419 metres upstream) will again consist of two-stage channel works whereby the top width of the channel will be increased from an average of 15m to a proposed width of 37m. The proposed works will again not involve excavation within the existing channel (in river works) and it is not proposed to alter the existing bed levels.

This method of construction again means that average annual flow can be contained within the existing channel and excavation can be undertaken along the bank with minimal interference to the water quality.

However, while it is proposed to undertake excavations along the left bank of the Dunkellin River, and that these works can be undertaken in dry bank conditions, such excavations have the potential to impact on the water quality of the river whereby silt may enter the river. This risk can be reduced or eliminated by operating in the dry conditions along the river bank.

Figure 3-5 provides an illustration of a typical cross section of the works to be undertaken along this section of the Dunkellin River.

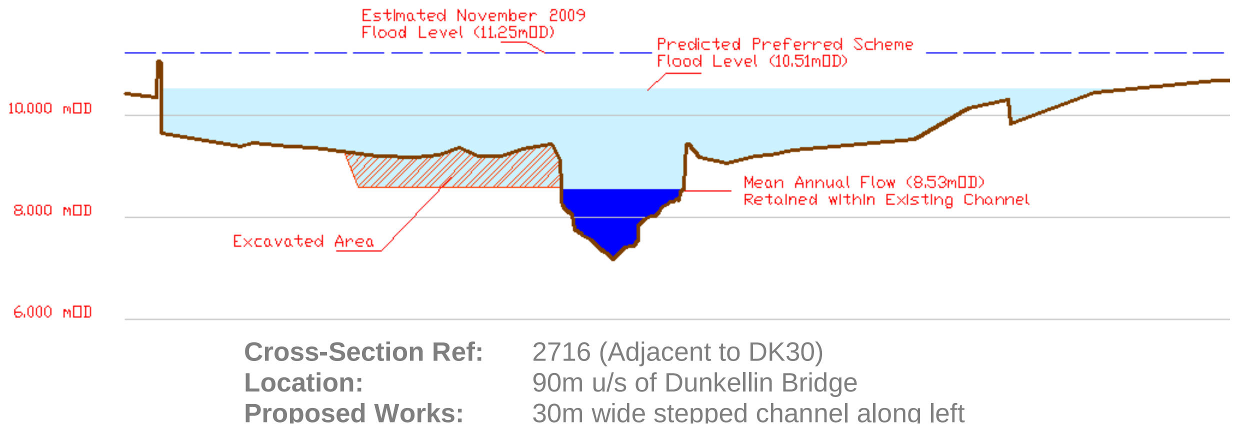


Figure 3-5– Proposed Works Channel Works from Dunkellin Bridge to Rinn Bridge

3.2.8 Works Item No. 8 – Works at Rinn Bridge

Engineering works in the townland of Rinn will include the provision of three bypass culverts on the left bank of the existing main concrete bridge. The existing structure at this location consists of a concrete flat deck bridge spanning the main channel with a single support located in the centre of the existing channel. It is not proposed to undertake any works on the existing bridge as the bed level of this bridge is considered to be a significant factor in controlling the water levels in the Rahasane Turlough cSAC. It is however proposed to provide three precast by pass culverts on the left bank of the existing channel. The culverts will consist of three precast concrete units measuring 3.1m wide by 2.1m high.

The proposed indicative bridge works are illustrated on Figure 3-6.

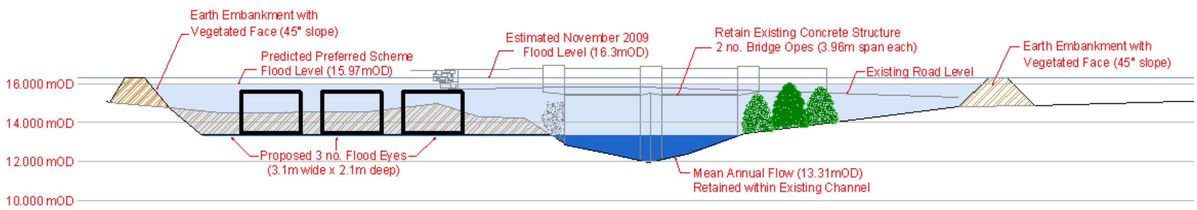


Figure 3-6 – Proposed Works at the Rinn Bridge

The construction of the proposed structures will require excavation of the existing road and will therefore require the closure of the existing public road and traffic disruption will be encountered.

However road diversions can be put in place on the northern approaches at Craughwell and along the southern approaches at Rinn and Madden's Forge with local access, to the northern and southern sides of the river, being maintained throughout the works.

3.2.9 Works Item No. 7 – Channel Works at Rinn Bridge

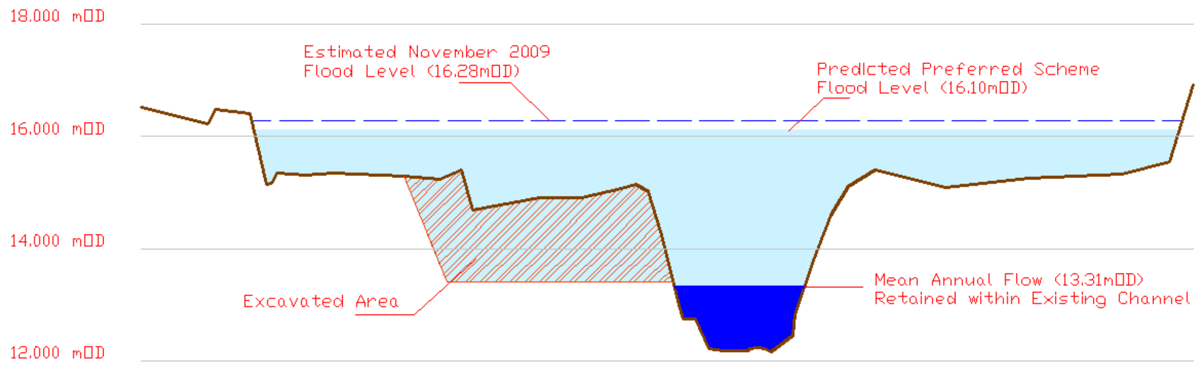
The proposed works at Rinn Bridge also include for the construction of two stage channel works for a distance of approximately 50m upstream and downstream of the bridge whereby the top width of the channel will be increased from an average of 21m to a proposed width of 41m. The proposed works will again not involve excavation within the existing channel (in river works) and it is not proposed to alter the existing bed levels. It is proposed to limit the extent of excavation in this section of channel to a maximum of 50m upstream of the bridge but also avoid excavation within the existing channel, so as to provide a natural hydraulic control for water levels in the turlough.

Strictly out of channel maintenance works aimed at the removal of encroachment of terrestrial vegetation, removal of fallen trees will be undertaken along the river bank where flood relief works are not undertaken. Terrestrial vegetation along the river banks would be managed (i.e. trimming back to 1.0m to 1.5m above high flood levels) rather than being removed.

However, while it is proposed to undertake excavations along the left bank of the Dunkellin River, and that these works can be undertaken in dry bank conditions, such excavations have the potential to impact on the water quality of the river whereby silt and other construction debris may enter the river. This risk can be reduced or eliminated by operating in the dry conditions along the river bank.

These proposed works will not enter the Rahasane Turlough cSAC.

Figure 3-7 provides an illustration of a typical cross section of the works to be undertaken at Rinn Bridge.



Cross-Section Ref:	4069 (Adjacent to DK26)
Location:	2m u/s of Rinn Bridge
Proposed Works:	20m wide stepped channel along left bank

Figure 3-7 – Proposed Works Channel Works from Rinn Bridge to the Rahasane Turlough

3.3 THE RAHASANE TURLOUGH CSAC (ZONE 2)

3.3.1 Item No. 6

Following development of Strategic Scheme No. 3, where channel deepening within the environs of Craughwell and channel & bridge widening downstream of the Rahasane Turlough were considered, it was found that proposed works would have an impact on the normal depth ranges of water within the turlough. This impact was thought to be environmentally significant and have the potential to impact on the normal hydrological and thus ecological regimes within the turlough. A fourth scheme, “Strategic Scheme No. 4” was therefore considered.

This fourth scheme considered the use of flood embankments or walls along the shore of the turlough without the need to change the depth of flooding within the turlough.

While offering flood protection on a theoretical basis, this proposal may not:

1. provide the necessary flood protection (from the Rahasane Turlough) due to the variable karstic nature of the bedrock in the region and the unpredictable potential movement of water beneath the flood protection wall or embankment (bringing a risk of “burst up” due to differential pressure of approximately 2.2m head across the wall), and

2. allow the drainage of surface/ground water, from lands along the northern boundary of the water body, behind the proposed wall, into the Rahasane Turlough, to occur naturally. This movement of water may be due to surface water flow or ground water movement in rock fissures or other unknown karstic features. Attempts to detail flexible pinch valves/flap valves to permit unidirectional drainage from behind the wall are unsound from a flood protection viewpoint, because such valves inevitably become blocked by debris in a partly open position.

Considering these risks the construction of flood embankments or walls in this karstic region were not considered viable and are therefore not proposed. However, the Craughwell to Kilcolgan Road and properties along the northern shore of the turlough will continue to be at risk of flooding during the extreme design flood events.

3.4 PROPOSED WORKS UPSTREAM OF THE RAHASANE TURLOUGH (ZONE 1)

3.4.1 *Works Item No. 1 – Channel Deepening from the Aggard Stream to Craughwell Village*

The proposed works, from a location approximately 600 metres downstream of the Railway Bridge in Craughwell (Chainage 9,426m) to a point 35m upstream of the R446 Road Bridge in Craughwell (Chainage 10,373m), will consist of channel regrading whereby the existing bed level will be lowered by 1.0 to 1.5 m over an approximate length of 950m. A summary of these works is given in Table 3-2. The proposed works will involve excavation within the existing channel (in-river works) and as such have the potential to impact on water quality in the area.

Table 3-2 – Craughwell channel works

Chainage	Location	Proposed Works
9426	Approximately 600 m downstream of Railway Bridge	Deepen Channel to 14.66 m.O.D. using side slope of 1:2
9426-10037	Downstream of Railway Bridge	Grade Channel from 14.66 m.O.D. to 16.83 m.O.D.
10037	Railway Bridge	Deepen Channel to 16.83 m.O.D. using side slope of 1:2
10037-10123	From Railway bridge approximately 127 m upstream	Grade Channel from 16.83 m.O.D. to 17.51 m.O.D.
10123-10373	Craughwell Village	Grade Channel from 17.51 m.O.D. to 17.85 m.O.D.
10373	Approximately 35 m upstream of Craughwell R446 Road Bridge	Deepen Channel to 17.85 m.O.D. using side slope of 1:2

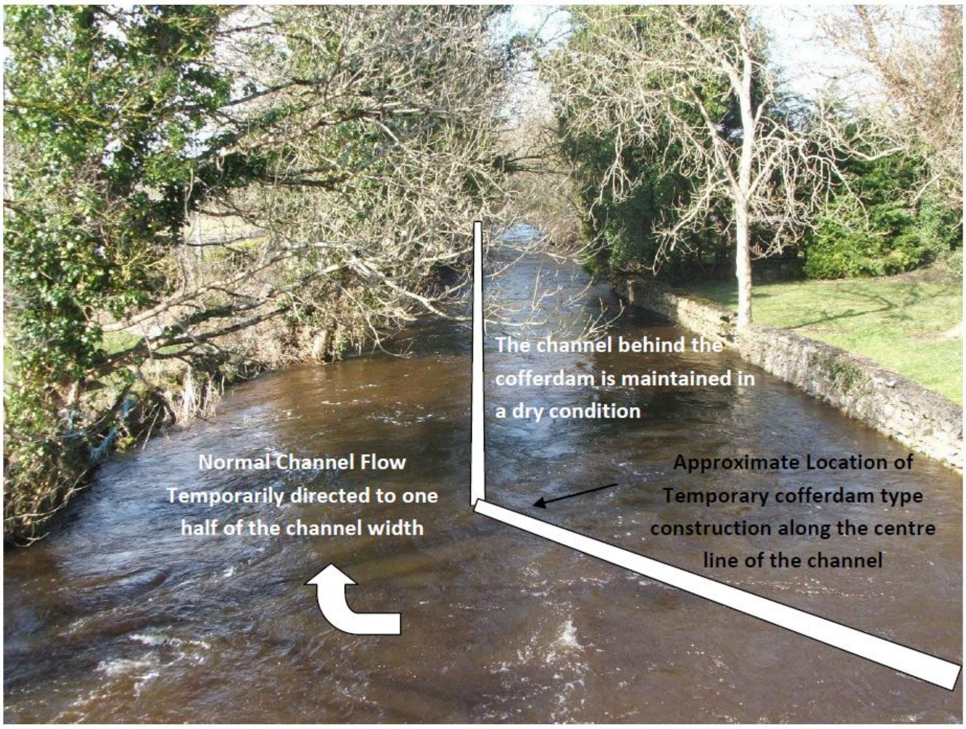
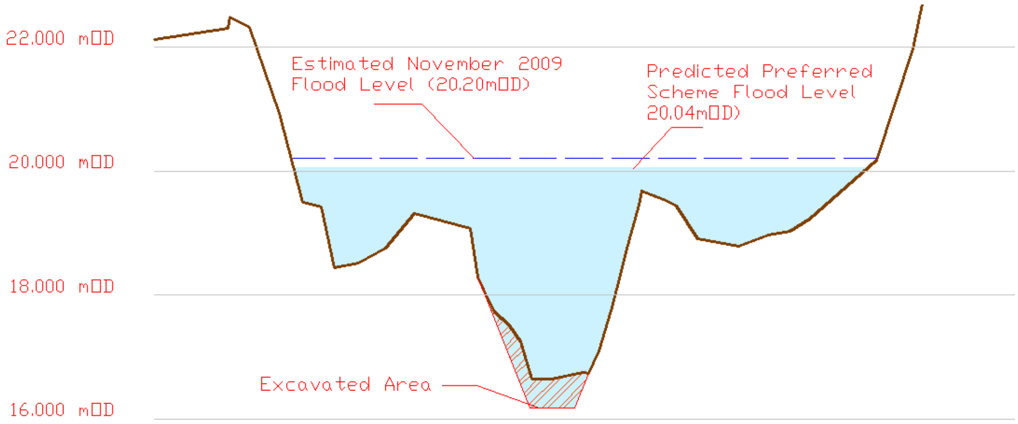


Figure 3-8 provides an illustration of a typical cross section of the works to be undertaken along this section of the river in the vicinity of Craughwell Village.



Cross-Section Ref: 9848 (Adjacent to DK10)
Location: 183m d/s of Railway Bridge
Proposed Works: Deepen Channel by approx. 0.6m

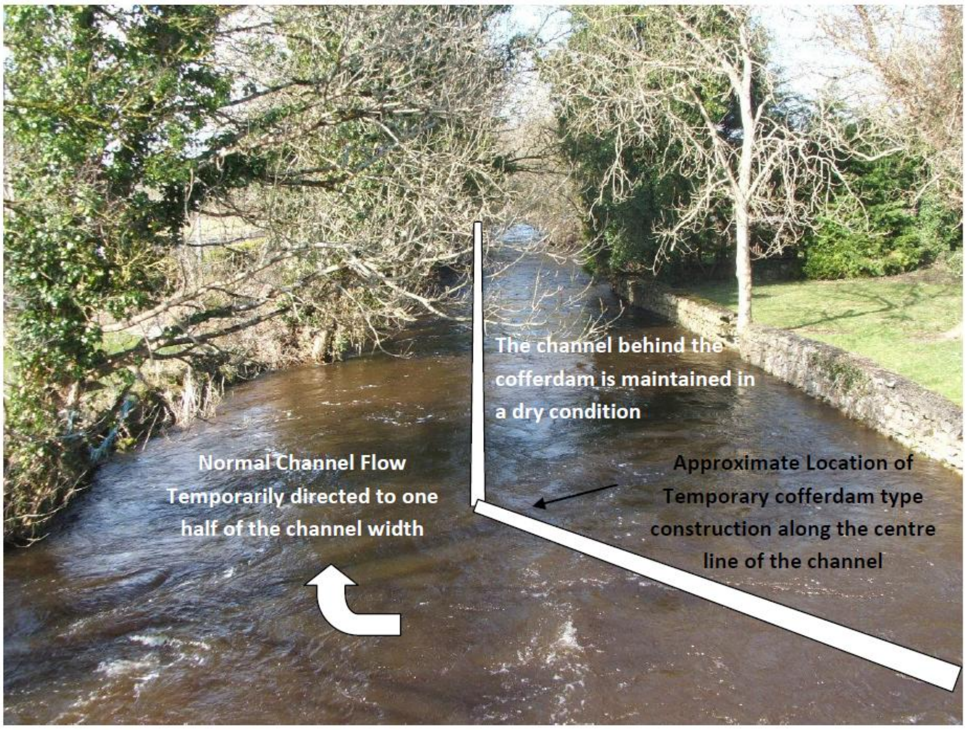


Figure 3-8 – Proposed Works Channel Works in the vicinity of Craughwell Village and sketch of cofferdam location

It is envisaged that excavation of the channel in this location will be dependent on the phasing of works along the bypass channel, low flow conditions in the river and the extent to which flow in the river can be diverted or restricted to one half of the existing channel. In addition it is also proposed to retain existing bankside trees (if healthy and suitable for retention) provided that their retention does not pose a concern with regard to the safe construction of the works, safe recreational use of the channel and safe maintenance of the channel. It is expected that a qualified arborist will be retained at the detailed design stage to examine and determine the most appropriate trees that can be retained or if necessary make recommendations with regard to the replacement of trees that require removal.

Works associated with channel deepening in the vicinity of the old stone bridge and the bridge crossings of the R446 can be undertaken in dry conditions whereby the bypass channel can be utilised a diversion route once the proposed channel works and underpinning on the bypass channel are complete.

The remaining channel works downstream of the proposed confluence of the bypass channel and the Dunkellin River will be undertaken along the length of the channel in segmented sections using cofferdam type temporary works construction.

It is envisaged that temporary cofferdam type construction or temporary sheet pile walls (with a length of 50 to 100m depending on the depth of water and ground conditions) will be used in the location described in Figure 3-8. This process allows river water to be directed to one half of the channel width allowing the civil engineering works to be undertaken, in relatively dry conditions, on the other side of the channel. Once this half of the proposed channel works is excavated, within the confines of the cofferdam, it is expected that river water will be directed to the new section allowing the adjacent excavations to be completed. This sequence of construction is expected to commence at the lower downstream point of the works and continue upstream in this "*leap-frog*" type construction method. This method of construction reduces the risk of construction debris and silt entering the river.

It is also proposed to store excavated material, such as the natural gravels, boulders and cobbles found on the existing river bed, so that such material can be reused in the development of the river enhancement works. The design of the river enhancement works together with the associated construction works method statements will be the subject of detailed design between Galway County Council, the OPW and Inland Fisheries Ireland upon conclusion of the planning process.

Such river enhancement works along this stretch of the river will aim to restore the natural morphological form (C type) of this channel at the new river bed level and develop a series of riffle, glide and pool structures. This process involves the reintroduction of some excavated material to create weirs or paired deflectors, excavation of pools and the introduction of salmonid spawning beds.

It is also proposed that the river enhancement works will be undertaken in tandem with the main excavations works within each cofferdam enclosure so that the short term impact on ecology is minimised.

3.4.2 Works Item No. 5, 3, and 2 – Works at the Railway Bridge, old multi-arched stone pedestrian bridge and main R446 Bridge in Craughwell

As noted in Section 3.3.1 it is proposed to regrade the main channel in Craughwell from a location downstream of the railway bridge to a location just upstream of the village. The regrading works will include a reduction in bed level in the range of 1.0 to 1.5m over an approximate length of 947m.

This regrading also requires the deepening of the bed level at the three main bridges in Craughwell, namely; the Railway Bridge, the old stone multi-arched pedestrian bridge and the bridge crossing on the R446. This proposed work is shown in Figure 3-9 to Figure 3-11 inclusive. The required depth of underpinning will be as follows:

1) Up to 0.50m of underpinning or scour protection required at the Railway Bridge
2) Up to 0.70m of underpinning at the old stone multi-arched pedestrian bridge and
3) Up to 0.60m of underpinning at the bridge crossing on the R446.

Underpinning or scour protection involves one of two main techniques whereby :

a) material is excavated from beneath the foundations of the existing bridge and replaced with mass concrete. The sequence of work is such that that the stability of the existing structure is not compromised. The work tends to be labour intensive and is normally undertaken in partial but sequential excavations under the bridge abutment.
b) a secant or contiguous piled wall is constructed along the foundation of the existing bridge to allow the deepening or regrading to take place.

It is envisaged that the foundations of the existing R446 road bridge and the stone arched pedestrian bridge will be supported through the use of direct underpinning i.e., item (a) above, where all of the work can be undertaken in the dry when the existing bypass channel is deepened and temporarily used as the main river channel for the duration of the underpinning and channel deepening. The underpinning of these structures will be labour intensive as the works will be undertaken by hand because headroom beneath each bridge soffit is minimal and access for heavy plant is limited.

It is envisaged that the foundations of the existing railway bridge will require scour protection through the use of a secant or contiguous piled wall along each side of the bridge piers or abutments i.e., item (b) above. However, this work will require the use of either a floating barge or construction of a temporary cofferdam to facilitate access to the bridge piers. The use of temporary cofferdams allows the works to be undertaken in two phases, whereby flow can be restricted to one half of the channel width allowing the civil engineering works to be undertaken in the dry conditions which exist within the other half of the channel.

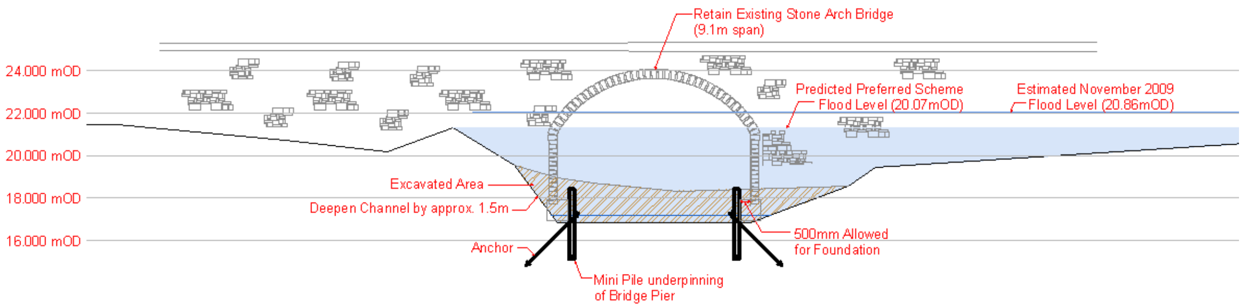


Figure 3-9 – Proposed Works at the Railway Bridge in Craughwell

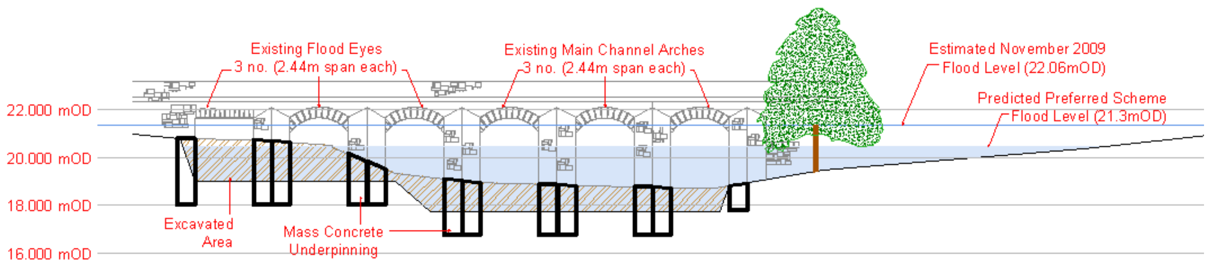


Figure 3-10 – Proposed Works at the Old Pedestrian Bridge in Craughwell

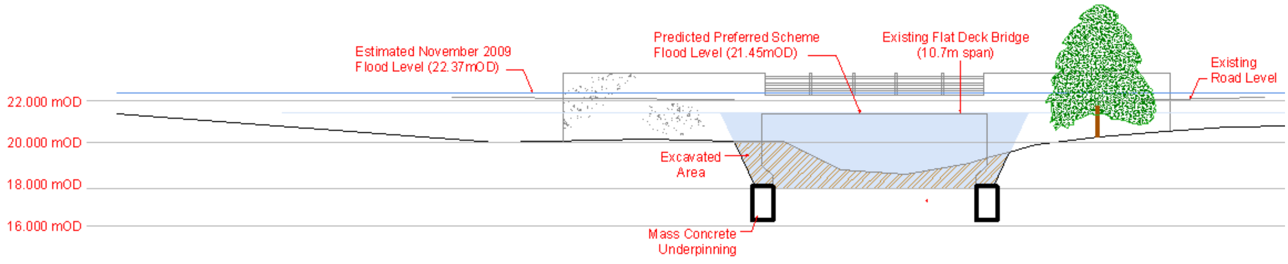


Figure 3-11 – Proposed Works at the R446 Road Bridge in Craughwell

3.4.3 Works Item No. 4 – Works along the By-Pass Channel

It is proposed to regrade the entire length of the bypass channel in Craughwell, from 18.5mOD upstream to 18.0mOD downstream. The regrading works will include a reduction in bed level of approximately 1.5m at the bypass bridge on the R446 road. This deepening will require underpinning of the existing bridge and it is envisaged that this will involve the excavation of material from beneath the foundations of the existing bridge and replacing this with mass concrete. The sequence of work is such that that the stability of the existing structure is not compromised. The work tends to be labour intensive and is normally undertaken in sequential excavations under the bridge abutment.

It is envisaged that this underpinning work can be undertaken in the dry as the bypass channel is normally only utilised when the main channel is in flood. The underpinning of this structure will again be labour intensive as the works will be undertaken by hand because headroom beneath the bridge soffit is minimal and access for heavy plant will be extremely limited.

Figure 3-12 provides an illustration of the works to be undertaken along this section of the bypass channel.

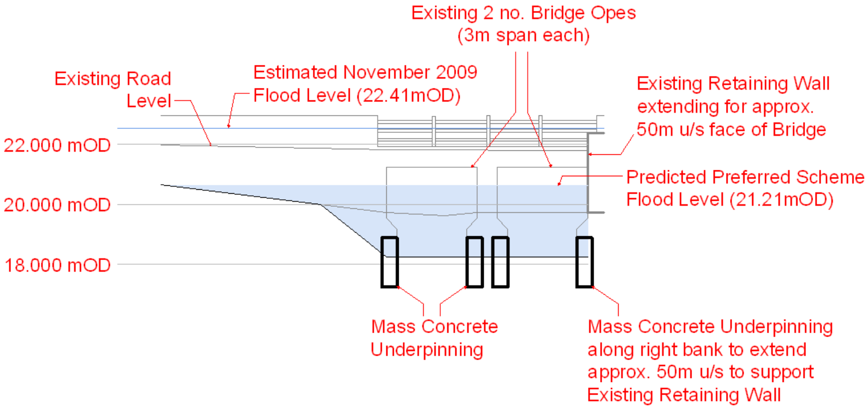


Figure 3-12 – Proposed Works at the By-Pass Channel Bridge in Craughwell

3.5 PROPOSED MAINTENANCE WORKS ALONG THE AGGARD STREAM

The proposed works along the Aggard Stream will consist of culvert replacement works whereby existing blocked and undersized piped crossings will be replaced with larger diameter piped culverts. The proposed works will involve minor localised excavations within the existing stream. The overall proposal for works along the Aggard Stream is to replace blocked culverts (circa 14 No. culverts) with 1500mm diameter precast concrete open jointed pipes.

Photographs No. 24 & 25 provide an illustration of typical culverts which require replacement along the Aggard Stream.

Photograph 24 – Typical Culvert along the Aggard Stream which requires replacement

Photograph 25 – Typical Culvert along the Aggard Stream which requires replacement

The works proposed for the Aggard Stream are minor in nature and consist of maintenance works aimed at the removal of encroachment of vegetation, removal of fallen trees and other obstacles (i.e. gates, minor obstructions, fences in the river poor culvert conveyance etc..), excessive silt deposits and that excavations not include for significant dredging and no channelization/arterial drainage works. Vegetation along the river banks would be managed (i.e. trimming back) rather than being removed, where at all possible.

3.6 ALTERNATIVES CONSIDERED AND OTHER PLANS OR PROJECTS IN THE AREA

3.6.1 Alternatives considered

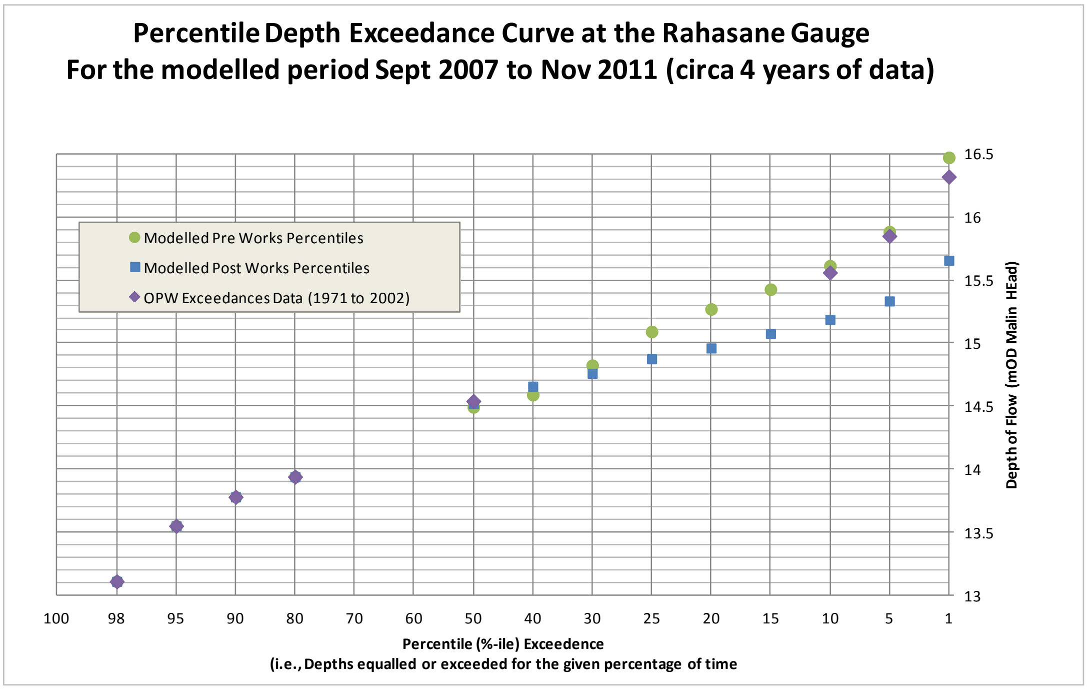
As noted in Section 3.1 four main strategic schemes were considered during the preliminary design stage of the project. Whilst the fourth scheme includes the preferred scheme flood relief measures, a series of alternative options were considered throughout the study area. These alternatives considered included :

Zone 1 Craughwell Village

a. Pumping of the excess flood river flows was considered at the early stages of the study. Whilst this proved to be an effective technical option the pumps were of a size that did not merit consideration. In addition, the pipework required was also significant in size and the flow velocities had the potential to create a risk of significance ground disturbance at their point of discharge.
b. Whilst demolition of the existing multi-arched stone pedestrian bridge was considered in the initial study, early consultation with statutory bodies indicated that even though the structure was not protected, the bridge was considered to be of archaeological significance and may also be used as a bat roost and as such demolition was not considered to be a viable option.
c. Channel widening of the existing river, within the village of Craughwell, was also considered at an early stage of the study. However, the main hydraulic restriction along this channel reach was the railway bridge. Channel widening would require the construction of a large flood culvert under the railway line. This alternative was not considered to be viable as installation of a large structure would require, for safety & health reasons, closure of the railway line for a significant period of time, a restriction not considered to be possible.
d. The provision of bypass culverts were also considered on each side of the R446 road bridges. However, due to localised access and land acquisition restrictions, the presence of existing utilities such as water mains, gas mains, broadband (fibre optic) facilities, underground power cables and Eircom cabling and the need for road closures on the R446 this option was not considered to be a viable solution.

Zone 2 Rahasane Turlough

a. Channel widening of the existing channel between the mouth of Rahasane Turlough to Rinn Bridge was also considered. Figure 3-13 shows the affect this widening has compared to the preferred scheme, most notably at levels over 15.7m. This alternative scheme is not considered to be viable as it has the potential to reduce the water profile in the Rahasane Turlough cSAC, to levels which would significantly impact on the normal flood regime and therefore impact on the local flora and fauna. This was not considered to be viable as the turlough is a protected habitat and heritage site.



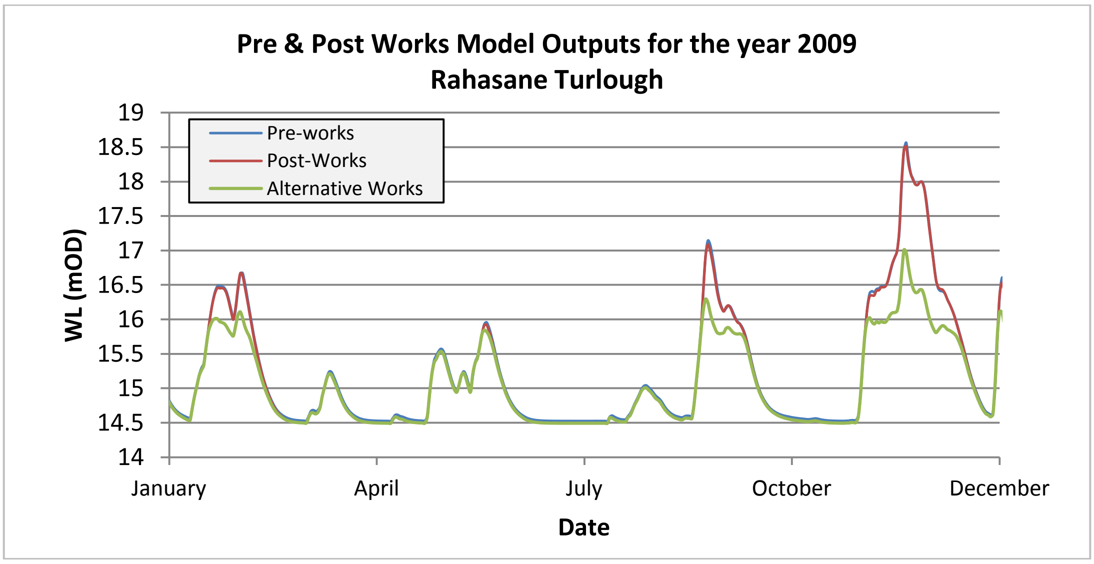


Figure 3-13 – Impact of Alternative Works on the depth ranges in the Rahasane Turlough

<u>**Zone 3 Downstream of the Rahasane Turlough to the N18 at Kilcolgan Bridge**</u>

a. Channel deepening of the existing river, downstream of the Rahasane Turlough cSAC, was also considered at an early stage of the study. However, the main hydraulic restriction along this channel reach was the water level in the turlough. Channel deepening would result in significant reductions in bed levels throughout this reach of the river. This alternative was not considered to be viable as it has the potential to reduce the water profile in the Rahasane Turlough cSAC, to levels which would significantly impact on the normal flood regime and therefore impact on the local flora and fauna. This was not considered to be viable as the turlough is a protected habitat and heritage site.

3.6.2 Other Plans or Projects in the Area

Work on the construction of new motorway between Gort and Tuam in Co Galway is expected to begin in late 2014/early 2015. The new 57km motorway will consist of a four lane carriageway from Gort in the south to Tuam in the north, and a major junction with the M6 Galway-Dublin route to the east of Galway City. The road will bypass Tuam, Ardrahan, Claregalway, Kilcolgan, Clarinbridge and Gort and the first traffic along the route is expected in 2018. The location of the proposed motorway is detailed on Drawing No's 6408-2201 and 6408-2204.

In preparing the EIS (dated August 2006), for the proposed motorway, a number of studies were undertaken to assess what impacts this road scheme would have on the surface water hydrology of the region. The proposed road crosses two rivers, the Clarinbridge River and the Dunkellin River.

With regard to the proposed Dunkellin and Aggard Flood Relief Scheme the proposed motorway will cross the Dunkellin River at a point approximately 600m upstream of the Dunkellin Bridge and 400m upstream of where the proposed flood relief scheme will commence.

The EIS for the motorway noted that:

In Section 8.2.1.2 under the heading of Effects of Proposed Development

"The proposed crossing point for the new N18 is located approximately 2.5km upstream of the existing N18, between Dunkellin Bridge and Rinn Bridge. The proposed crossing will consist of a three span bridge spanning the main river channel and a portion of the floodplain on either side. The preliminary span sizes used in this study are 35m for the central span, and 25m for side spans on either side. The river channel at the proposed crossing point has a width of approximately 20m. The bridge will therefore span approximately 65m of floodplain beside the river channel. It is possible that the span widths may be adjusted during detailed design. The road approaching the bridge will pass over the Dunkellin flood plain on embankments for approximately 300m."

In Section 8.4.2 of the EIS, under the heading of Hydrology

"Surface water will be attenuated through treatment ponds before entering the watercourse. This will reduce the volume of water entering the river to a peak flow equal to the green field runoff rate. This is not expected to have any significant or measurable impact on the river flows."

In Section 8.4.2.2 of the EIS, under the heading of Hydrology and referring specifically to the Dunkellin Turlough just upstream of the Dunkellin Bridge,

"The proposed crossing of the Dunkellin River requires approximately 300m of embankment to be constructed in the Dunkellin River flood plain. This causes a constriction in the flow at the proposed crossing point, and depending on the degree of constriction, bridge construction can cause considerable afflux, or backwater, upstream of the crossing. The crossing was modelled to estimate the extent of afflux which would be caused"

"The modelling showed that the overall water levels in the Dunkellin floodplain are controlled by the restriction imposed on flow in the river by the existing Dunkellin Bridge, and by a high bed level immediately downstream of the bridge…………..The model predicts a maximum difference in pre and post development water levels of 11mm just upstream of the bridge, reducing gradually to no difference approximately 450m upstream. There is no predicted difference in the downstream water levels from the bridge."

“The construction of the proposed new dual carriageway crossing is therefore expected to have a slight negative impact on the hydrology of the Dunkellin River. This impact will, however, be imperceptible due to the negligible amount of additional land flooded during extreme flood events due to the 11mm rise in water levels.”

The proposed motorway has been considered in the overall context of plans and projects in the vicinity of the proposed flood relief works, and because:

a. the proposed Dunkellin and Aggard Flood Relief Scheme commences at a location approximately 400m downstream of the M18 bridge crossing, and
b. the proposed M18 bridge crossing at Dunkellin is not expected to have an impact on water levels downstream of the new motorway bridge,

it is expected, that there will be no additional impact, from the M18, on water levels associated with the proposed Dunkellin and Aggard Flood Relief Scheme.

3.7 ENVIRONMENTAL RIVER ENHANCEMENT PROGRAMME

Inland Fisheries Ireland (IFI) define the Environmental River Enhancement Programme as :

“an Office of Public Works (OPW) funded project that is being co-ordinated and managed by Inland Fisheries Ireland. The programme focuses on the enhancement of drained salmonid rivers in Ireland. These drained rivers are a result of a number of large and small scale arterial drainage schemes which were carried out, across the country, by the OPW since the 1940’s. While such works substantially reduced flooding in many areas and brought much benefit to agriculture there were unfortunately some negative impacts on fisheries, angling and on the river corridor habitat.”

“Monitoring of the enhancement works by IFI consists of carrying out pre and post works habitat assessments on representative river stretches….. In parallel, pre and post works biodiversity assessments at representative river stretches scheduled for development are also carried out. These include surveys of aquatic insects; river corridor vegetation and other dependent river corridor animals and birds as appropriate”

Galway County Council, in consultation with the OPW, have undertaken to implement, in conjunction with the proposed channel works, a programme of River Enhancement Works along the Dunkellin River.

Two reaches of the Dunkellin River have been identified as areas with high enhancement potential. These are highlighted in Figure 3-14 and are :

1. the channel stretching from the N18 at Kilcolgan to the Rahasane Turlough, and
2. the channel reach stretching from the Rahasane Turlough to the Railway Bridge and upstream to the R446 road bridge in Craughwell Village.

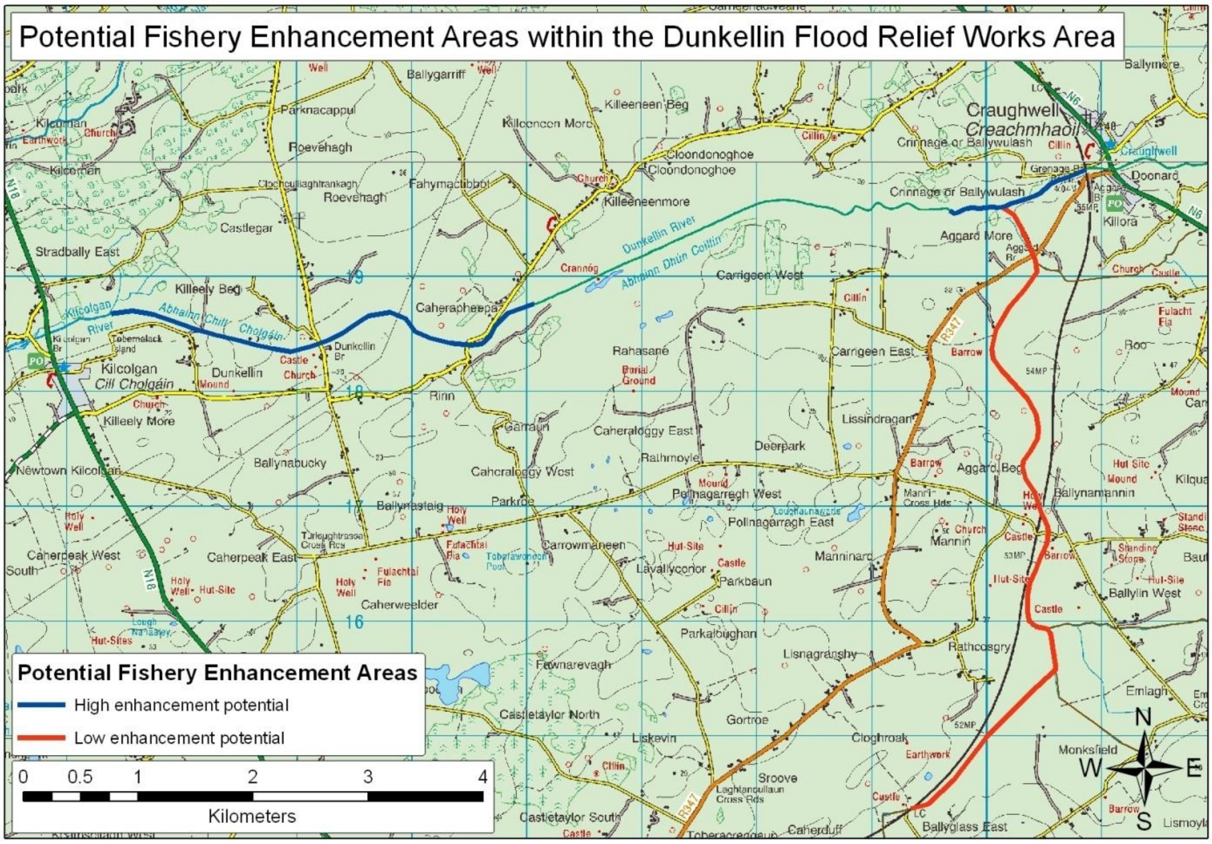


Figure 3-14 – Proposed Locations of River Enhancement Works

The aims of the programme, as defined by the IFI and OPW are to :

1. *"assist in achieving Good Ecological Status of drained rivers, and*
2. *improve biodiversity on drained salmonid rivers in Ireland while also maintaining their drainage function."*

In the case of the Dunkellin River it is proposed to utilise a number of enhancement details, including the :

1. provision of Centre Channel Pools.
2. provision of Lateral Scour Pools.
3. selected placement of gravel beds.
4. provision of Spawning Gravel at particular locations.
5. provision of rubble mats.
6. provision of paired stone deflectors.
7. Supply of alternating stone deflectors.
8. Vortex Stone Weirs.

With particular regard to the proposed channel deepening at Craughwell Village it is proposed that particular regard will be given to the gradient of the bed and the resultant impact on channel velocities. Following consultation with Inland Fisheries Ireland, the following site specific river enhancement methods will be undertaken between the confluence of the Aggard Stream/Craughwell River and Craughwell Village.

1. It is proposed to retain and store, on-site in designated areas, suitable excavated material such as the natural gravels, boulders, cobbles and sands for the purposes of habitat reinstatement. An area of land for the stockpiled

material and subsequent spreading of surplus material is detailed on Drawing No. 6408-2208.

2. A depth range or additional dredge depth of 500mm below the proposed design hydraulic bed level (water conveyance level) has been designated for the purposes of creating shallower bed levels and riffle/glide/pool sequences along the new channel. This depth range is detailed on Drawing No. 6408-2208.

Further details of the typical enhancements are contained in Appendix 3 of this section of the EIS.

4 HYDRAULIC IMPACT OF THE PROPOSED SCHEME

Following the development of the Preferred Scheme, as outlined in Table 3.1, an examination of the capacity of the proposed channel was undertaken to establish its performance to accommodate a range of flows.

For the purpose of this examination a series of extreme flows up to and including the November 2009 flow, were applied to the *"Preferred Scheme"* hydraulic model. The magnitudes of these flows are shown in Table 4-1.

These flows were provided by the OPW for the hydrometric stations at the R446 Bridge in Craughwell and the Aggard Bridge.

Table 4-1 – Magnitudes of Flow Scenarios Applied to the Hydraulic Model to Evaluate the Performance of the Preferred Scheme

	Hydrometric Station	
Flow Scenario	Craughwell Station No. 29007 (m^3/s)	Aggard Bridge Station No. 29010 (m^3/s)
Mean Annual Flow	4.205	0.857
10 percentile	12.2	1.9
5 percentile	16.2	2.48
Peak November 2009 Flow	84.8	21.46

4.1 EFFECT OF THE PROPOSED TWO-STAGE CHANNEL WORKS (CHANNEL WIDENING) ON WATER LEVELS IN THE CHANNEL DOWNSTREAM OF THE RAHASANE TURLOUGH CSAC.

Figures 4.1 to 4.3, inclusive, show a series of cross sectional views at a number of locations along the proposed channel downstream of the Rahasane Turlough cSAC. The predicted water surface profile, post works, for the various flow scenarios, as detailed in Table 4-1, are also shown.

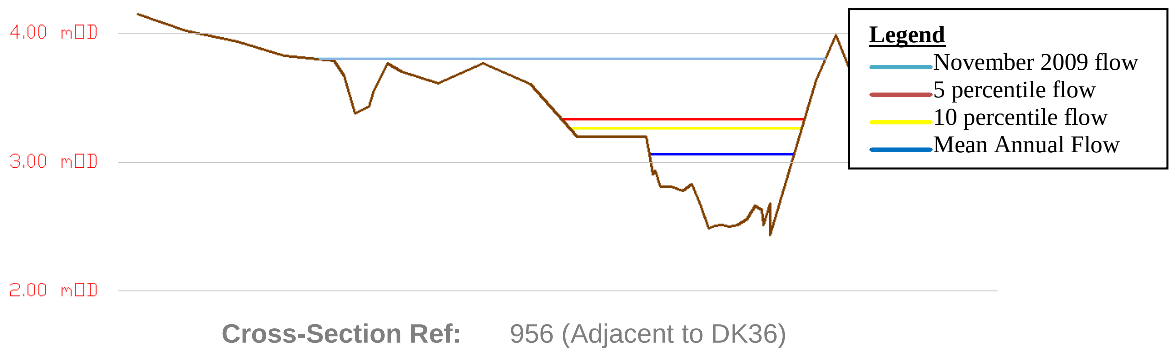
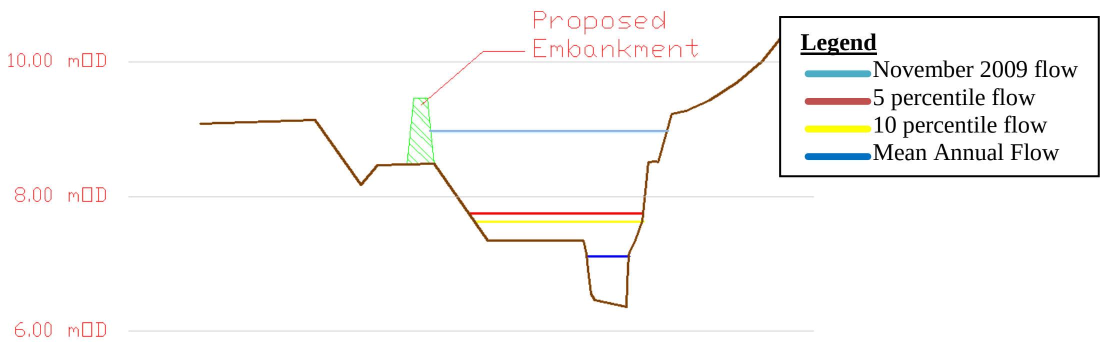
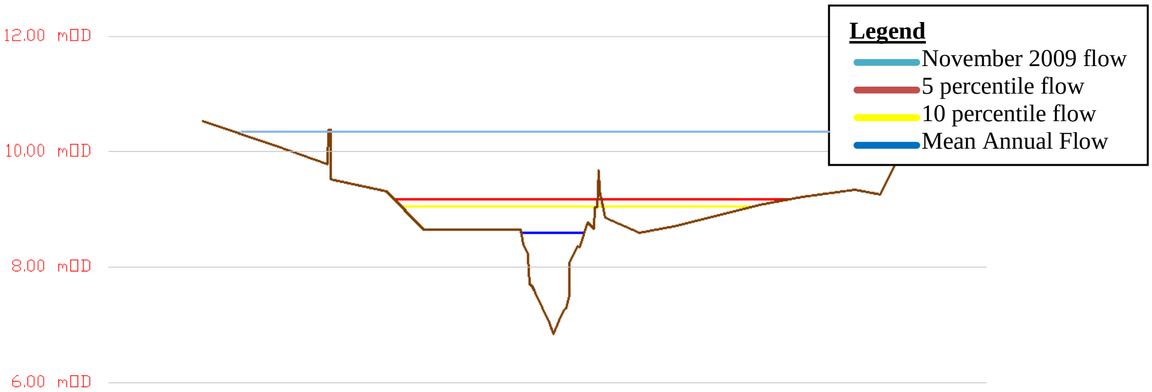


Figure 4-1 – Proposed channel downstream of Killeely Beg Bridge



Cross-Section Ref: 2286 (Adjacent to DK31)

Figure 4-2 – Proposed channel downstream of Dunkellin Bridge



Cross-Section Ref: 2796 (Adjacent to DK27)

Figure 4-3 – Proposed channel downstream of Rinn Bridge

These sample cross sections demonstrate that the post works water surface profile associated with Mean Annual Flow is in most cases contained within the main channel downstream of the Rinn Bridge. Attempting to fully contain the higher 5 and 10 percentile flows within banks would lead to impractical widening and riparian disruption.

4.2 CHANGES TO SURFACE WATER PROFILE WITHIN THE RAHASANE TURLOUGH CSAC FOR A DEFINED RANGE OF FLOWS

The proposed alterations to the Dunkellin River and its bridges have the potential to alter the flow regime of the Rahasane Turlough cSAC. The impact, of the proposed works, across the range of flows detailed in Table 4-1 and the predicted surface water profile for each flow scenario were also examined as part of this stage of the project, albeit with reduced confidence due to the high flow that was used to calibrate the model.

Figure 4-4 shows the predicted surface water profile along the length of the Rahasane Turlough cSAC when the November 2009 flood event (which has been estimated to be a 1 in

122 year return event). Figure 4-5 shows the Rahasane Turlough when a 2 year return flood event is applied to the model of the preferred scheme.

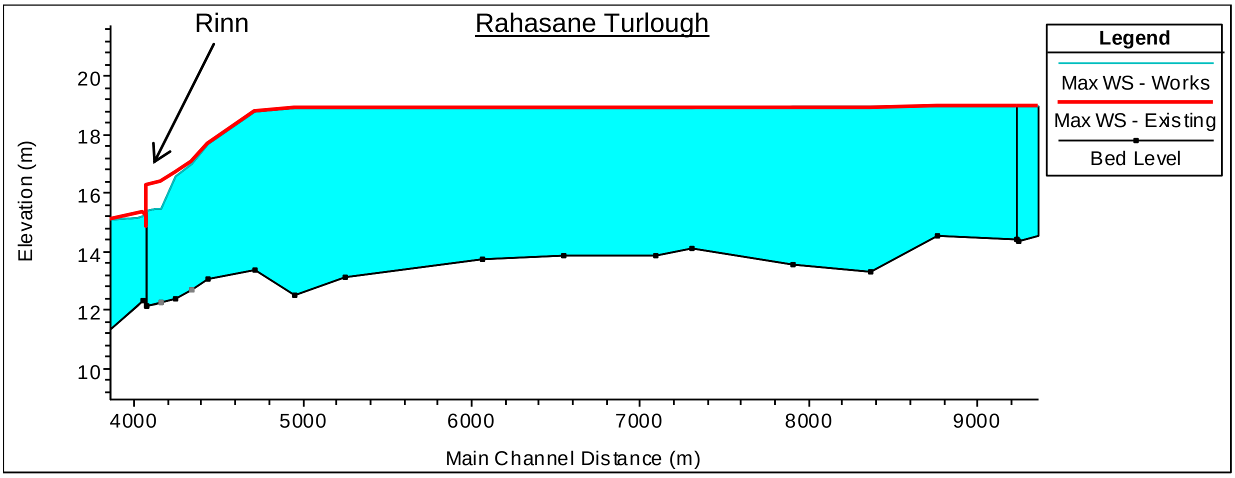


Figure 4-4 – Water Levels in Rahasane Turlough based on November 2009 Flood Flows

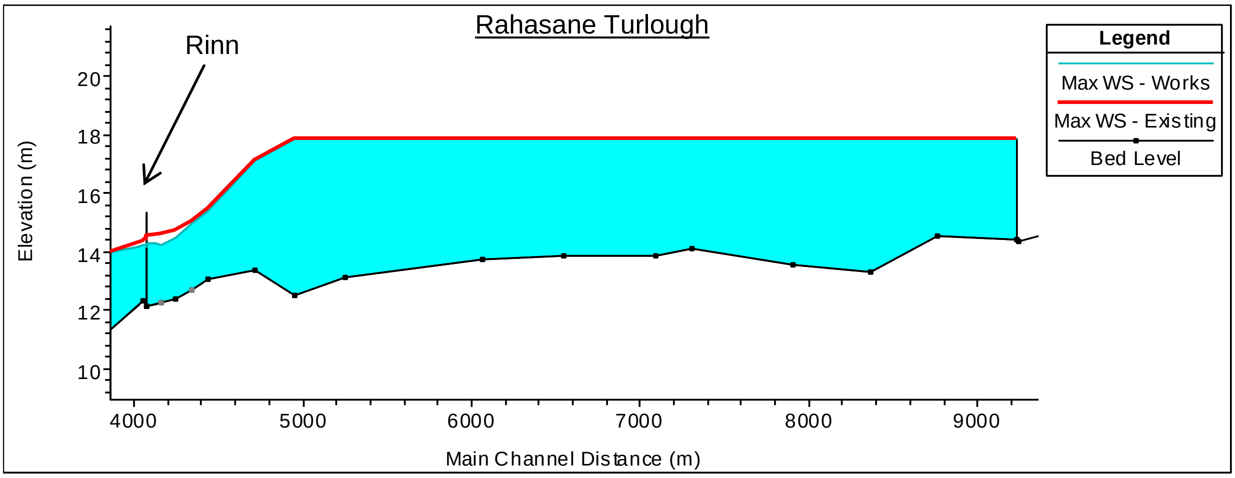


Figure 4-5 – Water Levels in Rahasane Turlough based on a 2-Year Return Period Event

From the diagrams it is clear that there are no changes expected in the water surface profile through the Rahasane Turlough for any magnitude of flood.

Figure 4-6 shows the predicted surface water profile at a cross sectional location within the Rahasane Turlough cSAC when the November 2009 Flood event, the 5%ile and the 10%ile flow events are applied to the model. It is again clear from these figures that there an almost undetectable change in the water levels in the turlough for these events.

In summary, it is predicted that, both average wet weather flows and very high flood flows will give rise to similar water levels on the turlough.

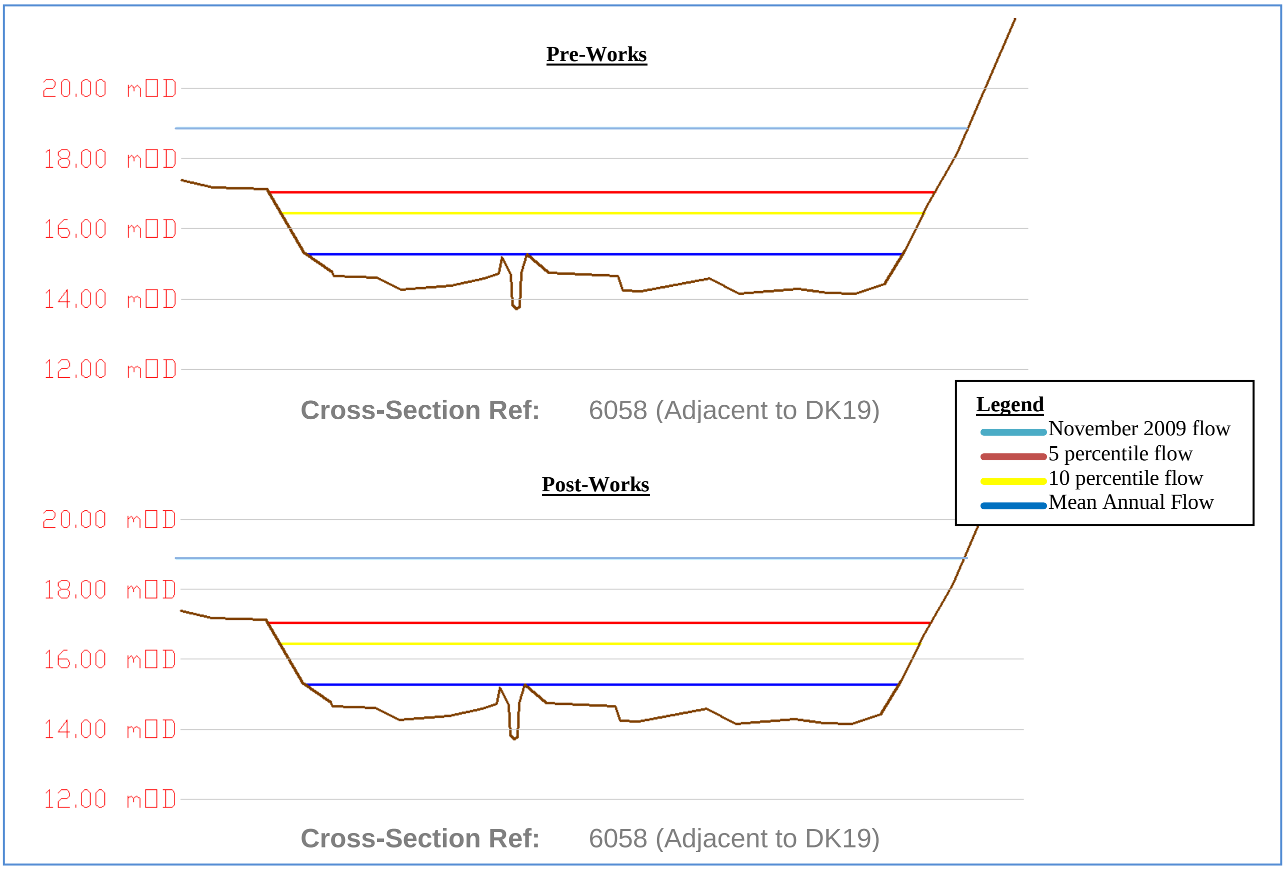


Figure 4-6 – Cross Section through Rahasane Turlough with estimated pre and post works water levels based on various flows

Figure 4-7 shows the estimated outline (in red) of the November 2009 flood event before the proposed works are implemented and also shows the predicted flood outline (in blue) when the same peak discharge 106.2m^3/sec (84.8 + 21.4 m^3/sec) is applied to the preferred scheme (i.e. after flood alleviation works are implemented).

There are no predicted changes in peak water levels, resulting from flood events similar to the November 2009 occurrence.

There is no estimated reduction in plan area for the November 2009 event.

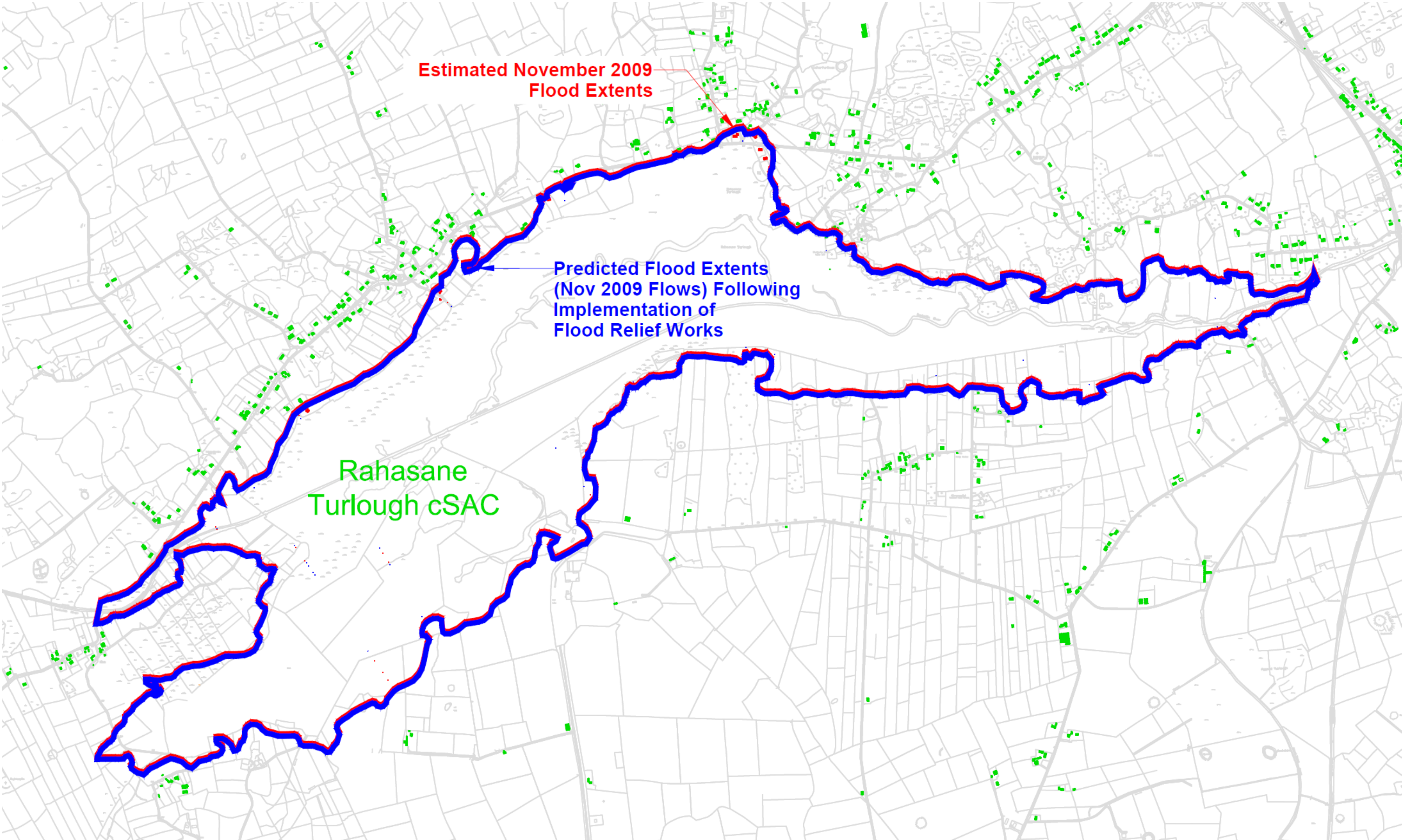


Figure 4-7 – Estimated extent of the flood plain within the Rahasane Turlough as generated by November 2009 Flows (pre and post flood alleviation works)

Figure 4-8 shows the effect of the proposed scheme on the Rahasane Turlough over 4 years of modelled flow between 2008 and 2011. This is further illustrated in Appendix No. 2. Based on this it is predicted that the Turlough will continue to behave as it does naturally at present.

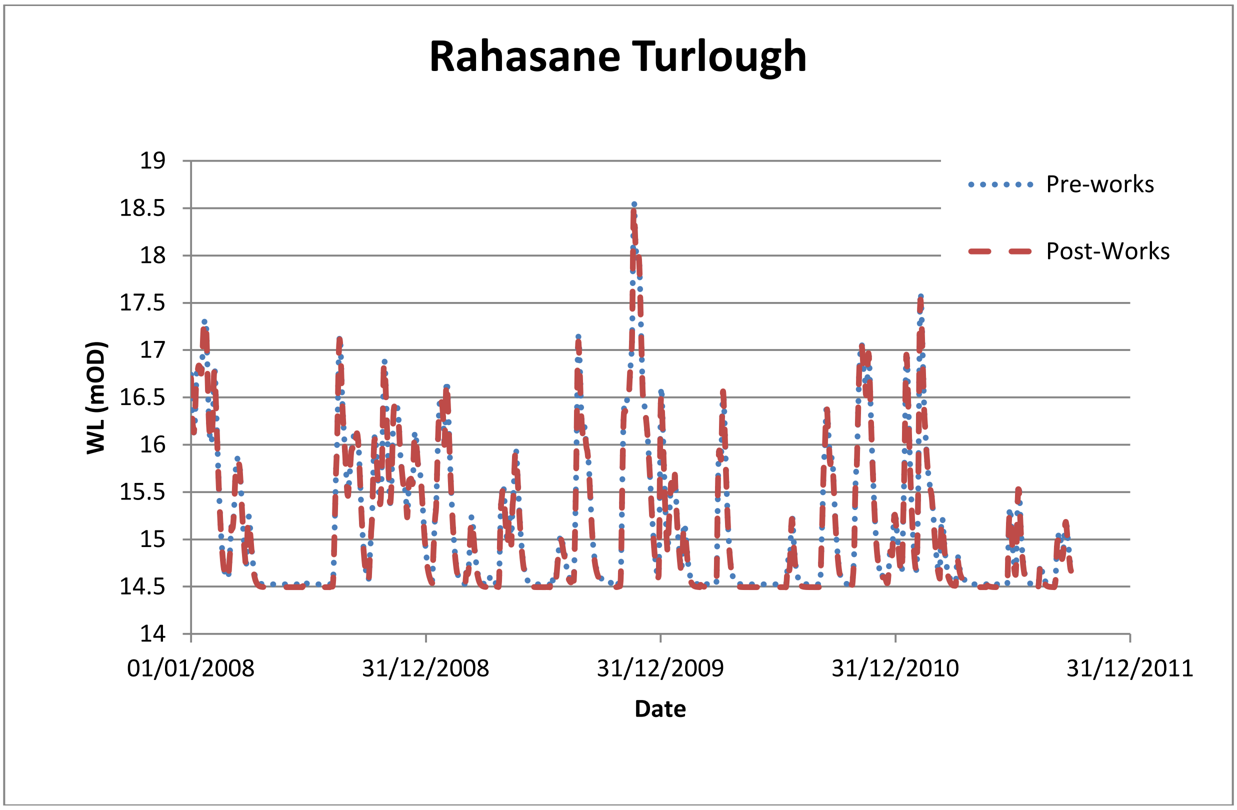


Figure 4-8 – Pre & Post Works Model Output (Depth of Flow at Rahasane)

4.3 IMPACT ON FLOW VELOCITIES

The scouring action of flood waters has the potential to impact on the water quality of the Dunkellin River and Rahasane Turlough cSAC and Galway Bay cSAC. Channel velocities play a significant part in the volume of sediment carried in suspension. During this current planning stage, the changes in flow velocities for the existing channel and proposed channel as modelled for the November 2009 flows were examined. It was found that flow velocities associated with the "Preferred Scheme", were predicted to be slightly higher than those estimated for the November 2009 event.

Open channel velocities during the November 2009 design flood (122 year flood) are in most cases predicted to have increased slightly in the new channel when compared with the existing channel. Table 4-2 summarises the estimated flow velocities at a number of locations along the Dunkellin River, when the November 2009 event is applied to the existing channel and the proposed channel.

Table 4-2 – Peak Velocities along the Dunkellin River for the November 2009 Event as predicted for the Existing Channel and Preferred Scheme

Location	Estimated Channel Velocities (m/s)					
	2009 Event		5 Year		2 Year	
	Pre-Works	Post-Works	Pre-Works	Post-Works	Pre-Works	Post-Works
Between R446 Bridge and Masonry Arch Pedestrian Bridge	1.07	1.08	0.86	1.07	0.95	1.13
Between Masonry Arch Pedestrian Bridge and Railway Bridge	1.05	1.3	0.98	1.78	1.03	1.75
d/s of Railway Bridge	1.67	1.87	1.08	1.13	1.21	1.26
Upper Rahasane Turlough	0.08	0.08	0.03	0.03	0.04	0.04
At Rinn Bridge	2.02	2.06	1.86	1.96	1.98	2.17
d/s of Rinn Bridge	1.72	1.16	1.57	0.83	1.55	0.9
d/s of Dunkellin Bridge	1.54	1.74	1.65	1.17	1.73	1.29
d/s of Killeely Beg Bridge	2.13	2.46	2.08	1.5	2.02	1.72

Examination of the channel velocities in the mathematical model (HEC-RAS) for the existing channel and Preferred Scheme scenario shows that expected changes in flow velocities is minimal.

4.4 IMPACT ON FLOW VOLUMES

The proposed alterations to the Dunkellin River and its bridges have the potential to alter the flow regime of the river system. The impact, of the proposed works, on the November 2009 flood event and the predicted hydrographs were also examined at this stage of the proposed scheme.

For the purpose of this study we have reviewed the peak discharge, hydrograph duration and cumulative volume of water discharged to Galway Bay during the November 2009 event. This examination was limited to a period of 206 hours starting approximately 95 hours before the peak of the November 2009 event.

The time to peak (T_p) is estimated to be reduced from 95 hours to 93 hours.

It is expected that implementation of the Preferred Scheme will result in a marginal increase (less than 1%) in the rate at which water is discharged to Galway Bay during a similar November 2009 flood event and on balance the volume of flood water passing Killeely Beg Bridge will not change significantly.

5 PROGRAMME AND PHASING OF THE WORKS

There are a number of constraints on the phasing and methods of construction works. The most significant constraint is that in general in-river work is only permitted between May and September each year.

This is a requirement resulting from the recommendations of a number of statutory bodies which were consulted during the early scoping stage of the planning stage. These include the Inland Fisheries Ireland, the NPWS and the timing restrictions are required to ensure that fish migration is not impeded during spawning seasons and that works do not impact on the crayfish populations who seek refuge within river banks during the winter months.

This programme is summarised in Figure 5-1 and it must be noted that this is an outline programme of works and may be subject to alterations subject to the timing of planning approvals, the final detailed design stage programme and following the appointment of a Works Contractor.

	No. of Employees	Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-15	Jul-15	Aug-15	Sep-15	Oct-15	Nov-15	Dec-15	Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Jul-16	Aug-16	Sep-16
Advanced Works																						
Vegetation Clearance		Vegetation Clearance			No Vegetation Clearance Permitted March to Sept					Vegetation Clearance Permitted Sept to February						No Vegetation Clearance Permitted March to Sept						
Out Of River Works downstream of the Rahasane Turlough																						
River Works Crew No. 1 – Out of River Works or Channel Widening of the Dunkellin River from Kilcolgan Bridge to Killeely Beg Bridge.	6																					
Channel Widening of the Dunkellin River from Killeely Beg Bridge to Dunkellin Bridge.	6																					
River Works Crew No. 1 – Out of River Works or Channel Widening of the Dunkellin River from Dunkellin Bridge to Rinn Bridge.	6																					
River Works Crew No.2 - Out of River Works or Channel Widening of the Dunkellin River from Rinn	6																					
Bridge Works Crew A – Bridge Works at Killeely Beg Bridge.	8																					
Bridge Works Crew B – Out of River Bridge (Left Bank Works) /Culvert Works at Dunkellin Bridge.	8																					
Bridge Works Crew C – Out of River Bridge (Left Bank Works) /Culvert Works at Rinn Bridge.	8																					
In River Works upstream of the Rahasane Turlough																						
Bridge Works Crew D– In River Works or Channel Deepening downstream of the Railway Bridge (Rock Removal).	4																					
Bridge Works Crew E– In River Works or Channel Deepening in Craughwell.	4																					
Bridge Works Crew F – In River Works or Underpinning at the Railway Bridge in Craughwell.	4																					
Out Of River Works on the Bypass Channel followed by works on main R446 bridge & Multi-Arched Bridge																						
Works Crew No. 1 – Out of River Works or Channel deepening and underpinning along the bypass channel and retaining walls	4																					
Works Crew No. 2 – Out of River Works or Underpinning of the Old Stone Multi-arched bridge (Extended Programme to cater for variability in river flows)	4											Restrictions Apply to Works within this Time Period										
Works Crew No. 3 – Out of River Works or Underpinning of the main R446 bridge in Craughwell (Extended Programme to cater for variability in river flows).	4																					
Landscaping																						
Completion/Snagging and Handover																						

Estimated Max Number of Employees on Site	44

Figure 5-1 – Outline Construction Programme

6 EXCAVATIONS AND EXCAVATED MATERIALS

All river regrading and widening will be undertaken using tracked vehicles travelling along the temporary works area along the bank of the Dunkellin River.

It is anticipated that approximately 70,000m³ of overburden, rock and riverbed will be removed from the river and its surroundings as a result of channel deepening and widening.

This is broken down in Table 6-1.

It is envisaged that different techniques will be adopted with regard to the reuse or disposal of excavated material. However, the overall intention will be to reuse the excavated material as side slope protection, creation of flood embankments, creation of bankside spoil embankments and the creation of extended spoil heaps where initial treatment will require removal of topsoil, spreading of excavated material and reinstatement of the topsoil, undertaken with a view to minimising the transport of material off-site.

It is proposed that the use of bank side spoil heaps will be of the order of the dimensions detailed in Figure 6-1 where the estimated cross sectional area of the spoil heap (outside areas where flood embankments are used) is not expected to exceed $6m^2$.

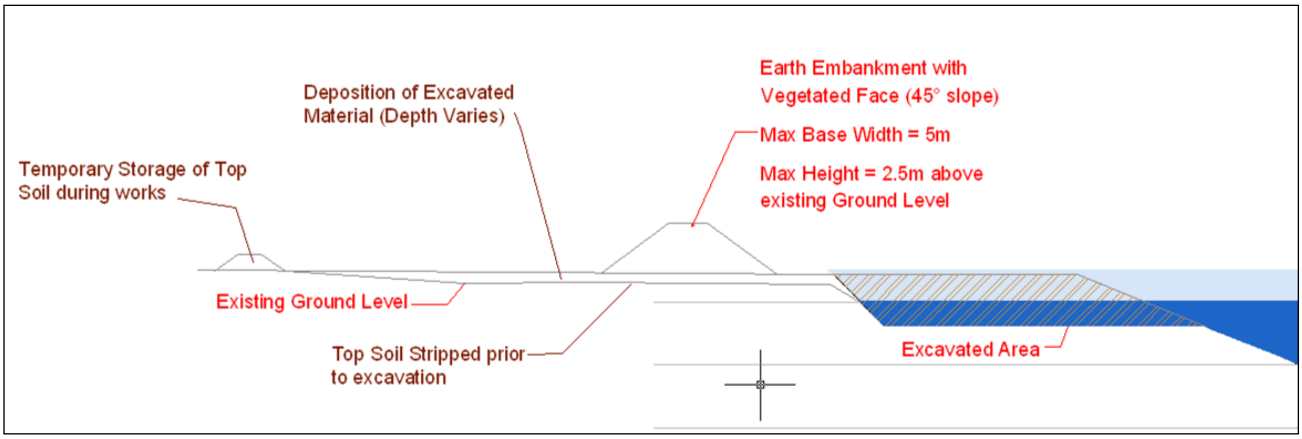


Figure 6-1 – Typical Detail of the Proposed Bank Side Spoil Heaps

Table 6-1 – Estimated Volumes of Excavated Materials

Area	Location	u/s Reference		d/s Reference	Distance (m)	Average X-Sectional Area to be excavated (m^2)	Typical Two-Stage Channel Width (m)	Typical Depth (m)	Volume (m^3)	Sub-Total (m^3)	Area Available for Spreading Spoil (m^2)	Approx. Depth of Land Spread (m)
Upstream of Rahasane Turlough	Craughwell Main Channel	10306		10285 (R446 Bridge)	36.00	12.69	-	1.50	457	5,233	45,002	0.12
		10285 (R446 Bridge)		10253 (Old Masonry Arch bridge)	31.97	13.94	-	1.00	446			
		10253 (Old Masonry Arch bridge)		10120	134.66	6.66	-	1.25	897			
		10120		10040 (Railway Bridge)	126.50	7.05	-	0.75	892			
		10040 (Railway Bridge)		9231	612.80	4.15	-	0.75	2,542			
	Bypass Channel	PYP 345		PYP 145 (R446 Bridge)	190.00	42.13	-	2.25	8,006	11,698		
		PYP 145 (R446 Bridge)		PYP 0	161.66	22.84	-	2.25	3,693			
										16,932		
Downstream of Rahasane Turlough	Rinn Bridge	4144		4119	25.00	19.99	10.00	2.00	500	5,318	21,906	0.24
		4119		4068 (Rinn Bridge)	50.00	39.98	20.00	2.00	1,999			
		4068 (Rinn Bridge)		4013	58.00	39.98	20.00	2.00	2,319			
		4013		3988	25.00	19.99	10.00	2.00	500			
	Upstream of Dunkellin Bridge	3045		2716	328.93	13.74	20.00	0.75	4,518	7,040	59,967	0.12
		2716		2666	50.00	23.65	25.00	1.00	1,182			
		2666		2626 (Dunkellin Bridge)	39.91	33.56	30.00	1.25	1,339			
	Dunkellin Bridge to Killeely Beg Bridge	2626 (Dunkellin Bridge)		2569	58.00	33.56	30.00	1.25	1,946	31,888	81,743	0.39
		2569		2519	50.00	32.52	25.00	1.50	1,626			
		2519		1709	810.00	31.49	20.00	1.75	25,507			
		1709		1659	50.00	29.22	17.00	1.75	1,461			
		1609		1559 (Killeely Beg Bridge)	50.00	26.96	14.00	2.00	1,348			
	Downstream of Killeely Beg Bridge	1559 (Killeely Beg Bridge)		1509	56.00	26.96	14.00	2.00	1,510	8,612	198,648	0.04
		1509		1459	50.00	17.17	17.00	1.25	858			
		1459		1059	400.00	7.37	20.00	0.50	2,949			
		1059		165	894.00	3.69	10.00	0.50	3,295			
										52,858		

Total Volume for Excavation = 69,790 m^3

The techniques are summarised items a) to f) over the following paragraphs.

a. Within the village of Craughwell, upstream of the railway bridge, it is expected that channel deepening along the Dunkellin and the bypass channel, will require the excavation of approximately 5,200m^3 of sandy/silty gravel with cobbles and boulders. It is expected that c. 3,500m^3 of this material can be reused in creating a flood defence embankment along the right bank of the Dunkellin River upstream of Craughwell as indicated in Figure 6-2. The remaining material will require disposal, at a licensed facility, in accordance with the Waste Management Act 1996.

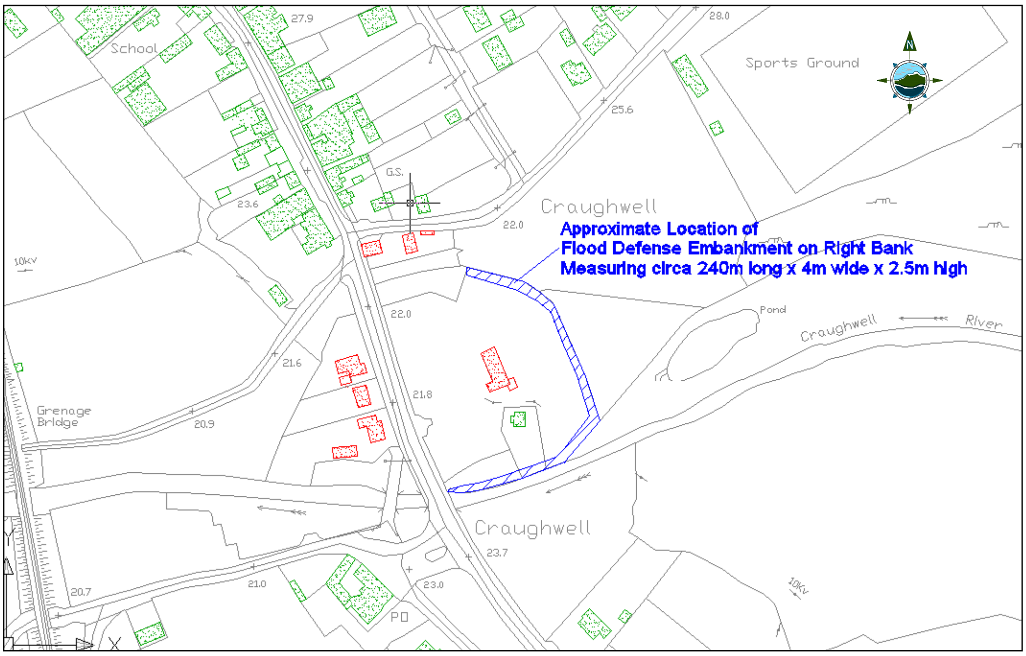


Figure 6-2 – Approximate Location of Flood Defence Embankment upstream of Craughwell

b. Downstream of Craughwell and the railway bridge, it is expected that channel deepening along the Dunkellin, will require the excavation of approximately 11,600m^3 of gravel with cobbles and boulders and a significant amount of rock. It is expected that c. 5,000m^3 of rock will be excavated and that this can be reused in creating side slope protection along the proposed channel deepening. It is expected that the remaining material which will consist of sandy gravels can be reused along the left & right banks. This technique will involve removal of tree growth on the banks, topsoil stripping (and storage) on the banks in advance of channel works, spreading of the excavated material across the works area and final reinstatement of the banks with the stored topsoil and final landscaping (tree planting) with native species. Alternatively, an embankment, constructed from excavated material may be created along the banks to minimise the need for transport of the excavated material away from the works area.

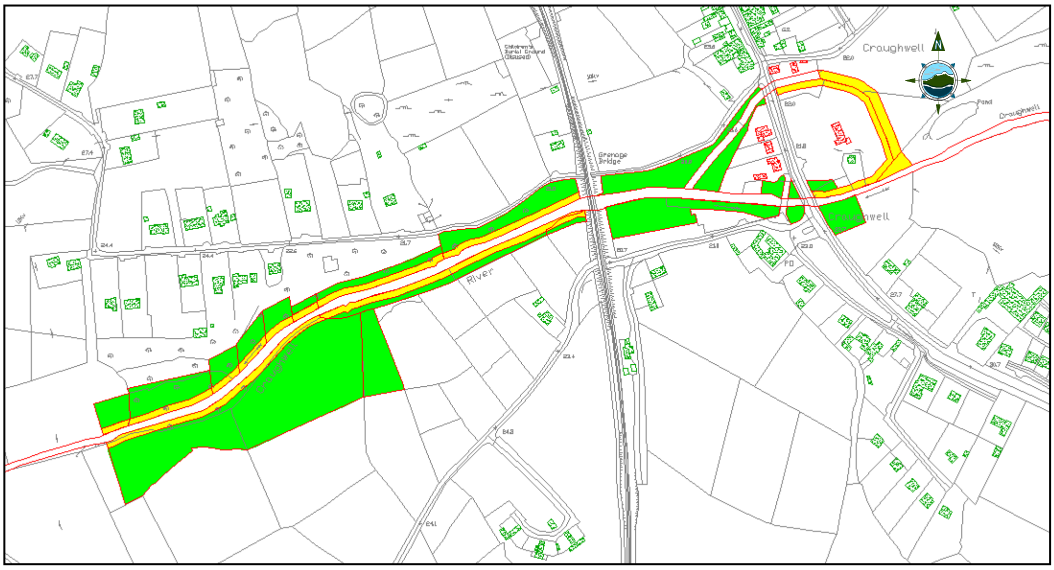


Figure 6-3 – Approximate Location of Lands required for temporary storage (River Enhancement Works) and deposition of excavated material (green) downstream of Craughwell Village (yellow indicates spoil heaps/embankments)

Photograph No. 26 – Approximate Location of Lands required for reuse of excavated material downstream of Craughwell Village

c. Downstream of the Rahasane Turlough cSAC but upstream of Rinn Bridge, it is expected that channel widening along the Dunkellin, will require the excavation of approximately 5,000m^3 of gravels and an amount of rock. It is expected that at least 3,500m^3 of rock will be excavated and that over 50% of this material can be reused in creating side slope protection along the lower reaches of the Dunkellin River, downstream of the Dunkellin Bridge. This will require significant traffic movement in the area to cater for this reuse of material. It is expected that the remaining material (circa 1,500m^3) which will consist of overburden or sandy gravels can be reused along the left bank. This technique will again involve topsoil stripping (and storage) on the left bank in advance of channel works, spreading of the excavated material across the stripped works area and reinstatement of the left bank with the stored topsoil. Alternatively, an embankment, constructed from excavated material may be created along the left bank to minimise the need for transport of the excavated material away from the works area.

Figure 6-4 – Approximate Location of Lands required for deposition of excavated material (green) upstream of Rinn Bridge (Yellow Areas indicate extent of channel excavations)

Photograph No. 27 – Location of Channel Works upstream of Rinn Bridge

d. Downstream of the Rinn Bridge but upstream of the Dunkellin Bridge, it is expected that channel widening along the Dunkellin, will require the excavation of approximately 7,000m^3 of gravels and rock. It is expected that circa. 5,500m^3 of rock will be excavated and that over 50% of this material can be reused in creating side slope protection along the lower reaches of the Dunkellin River, downstream of the Dunkellin Bridge. This will require significant traffic movement in the area to cater for this reuse of material. It is expected that the remaining material (circa 1,500m^3) which will consist of overburden or sandy gravels can be reused along the left bank to create an embankment along the outer extremes of the proposed channel widening. This technique will again involve topsoil stripping (and storage) on the left bank in advance of channel works, spreading and shaping of the excavated material across the stripped works area and reinstatement of the embankment left bank with the stored topsoil.

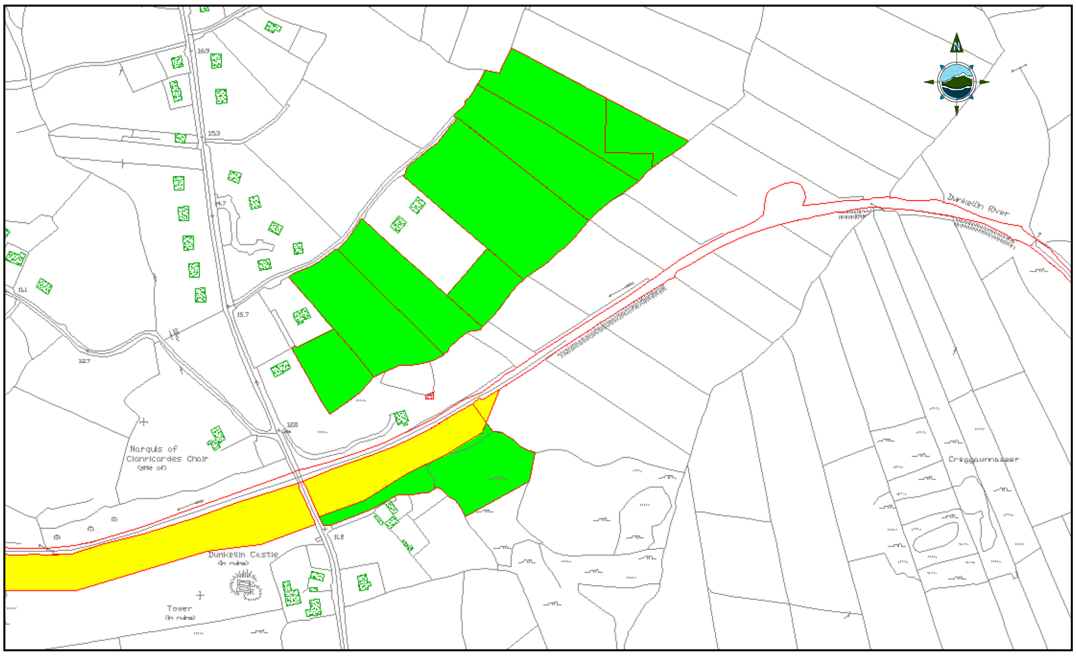
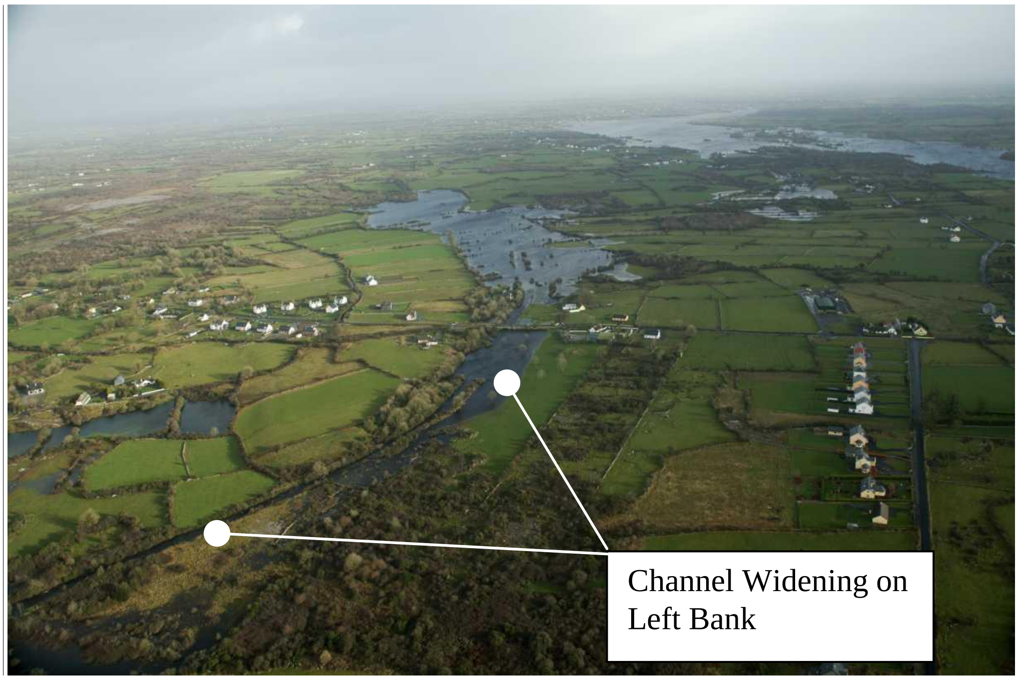


Figure 6-5 – Approximate Location of Lands required for deposition of excavated material (green) upstream of the Dunkellin Bridge (yellow areas indicate extent of channel works)

e. Downstream of the Dunkellin Bridge but upstream of the Killeely Beg Bridge, it is expected that channel widening along the Dunkellin River, will require the excavation of approximately 32,000m^3 of gravels and a significant amount of rock. It is expected that at least 20,000m^3 of gravels and rock will be excavated and that majority of this material can be reused in creating a left bank spoil embankment. This technique will again involve topsoil stripping (and storage) on the left bank in advance of channel works, spreading and or mounding of the excavated material across the stripped works area and reinstatement of the left bank with the stored topsoil. This technique will minimise the need for transport of the excavated material away from the works area.

Figure 6-6 – Approximate Location of Lands required for reuse of excavated material (green) upstream of Killeely Beg Bridge (yellow areas indicate extent of channel widening)



Photograph No. 28 – Location of Channel Works upstream of Killeely Beg Bridge

f. Downstream of the Killeely Beg Bridge but upstream of the N18, it is expected that channel widening along the Dunkellin River, will require the excavation of approximately 8,600m^3 of overburden, gravels and a portion of rock. It is expected that at least 6,000m^3 of gravels and rock will be excavated and that majority of this material can be reused in creating a left bank spoil embankment. This technique will again involve topsoil stripping (and storage) on the left bank in advance of channel works, spreading and or mounding of the excavated material across the stripped works area and reinstatement of the left bank with the stored topsoil. This technique will minimise the need for transport of the excavated material away from the works area.

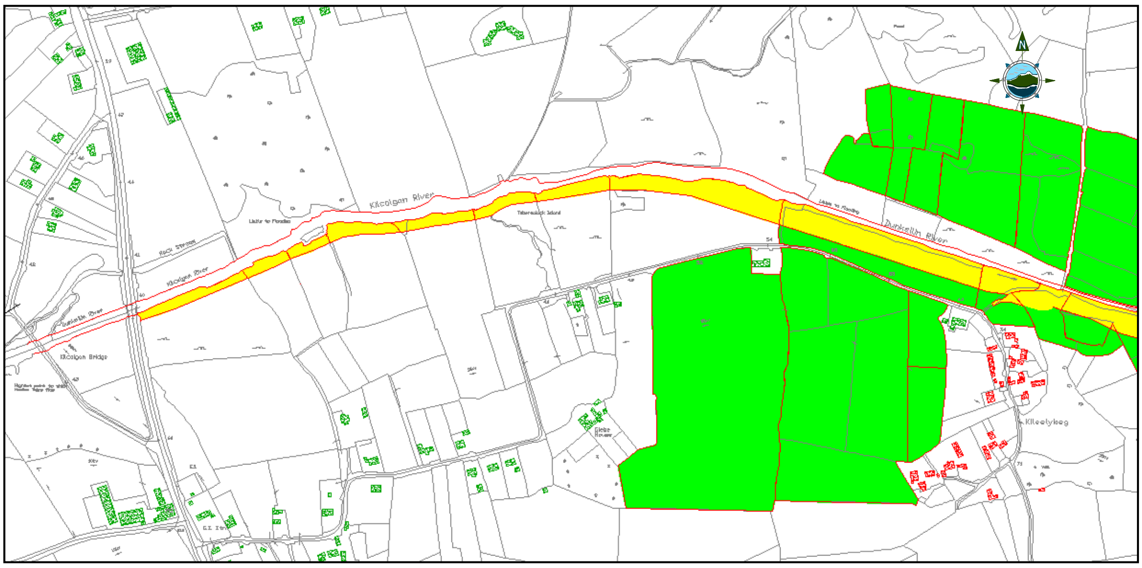
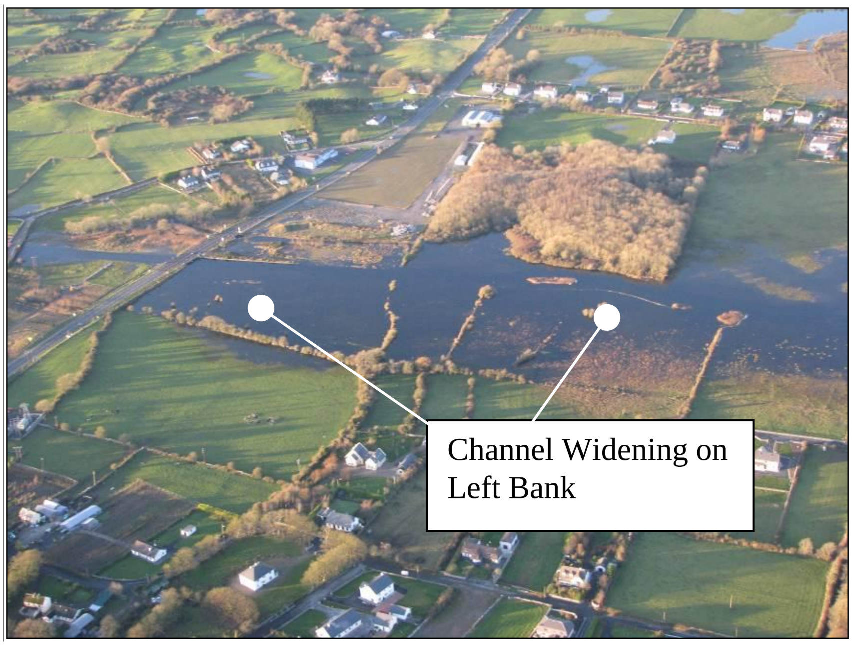


Figure 6-7 – Approximate Location of Lands required for deposition of excavated material (green) downstream of Killeely Beg Bridge (yellow areas indicate extent of channel works



Photograph No. 29 – Location of Channel Works downstream of Killeely Beg Bridge

7 ANCILLARY WORKS ITEMS & SITE ACCESS

7.1 WORKS ACCESS

It is envisaged that the construction of the proposed flood relief works will require the following ancillary works:-

i) Site compound at Killeely Beg Bridge.
ii) Site compound at Dunkellin Bridge.
iii) Site compound at Rinn Bridge.
iv) Provision of an access point into the Dunkellin River at Killeely Beg Bridge.
v) Provision of access point into the Dunkellin River at the Dunkellin Bridge.
vi) Provision of an access point into the Dunkellin River at Rinn Bridge
vii) Temporary access road to Killeely Beg Bridge to facilitate the movement of large precast bridge beams.
viii) Site compound at Craughwell Village.

As noted above it is envisaged that there will be four main site compounds which include short term staff welfare facilities and plant & materials storage for the proposed works.

An access point to the proposed river works will required at the three main locations detailed above. It is envisaged that these will consist of a temporary surface which will be provided along the river bank to allow vehicles to enter and travel to the proposed excavation sites.

It is envisaged that this track will be formed from stone excavated from the proposed works and will be constructed ahead of the excavation plant as work progresses.

7.2 DEALING WITH WATER WITHIN EXCAVATED WORKS

A number of the proposed works will require the use of dewatering pumps in order to maintain dry conditions within the excavations. It is envisaged that the construction of the proposed flood relief works will require the use of up to two (2) *"6 Inch"* dewatering pumps.

Such dewatering pumps have a capacity of up to 90l/sec and with two pumps in operation the maximum expected rate of trench/excavation dewatering could be of the order 180l/sec.

The use of such dewatering pumps will require the use of temporary constructed silt ponds for the disposal of excavated water.

8 EMERGENCY PROCEDURE DURING FLOOD EVENTS DURING CONSTRUCTION

With flooding events having occurred in January 2005 and November 2009 the likelihood of a flood event occurring during construction could be considered to be relatively high.

Although the proposed channel works are designed to provide flood relief, their construction may cause a temporary flow restriction along the channel particularly where bridge underpinning works are proposed. The contractor must therefore ensure that the risk of flooding is not increased as a result of the proposed works. Whilst rainfall in the catchment can result in significant flows, in the Dunkellin River, advance warning of such flood events is possible and the contractor will be required to monitor both long and short term weather forecasts so that machinery and personnel can be prevented from entering the channel during periods of peak flow. Monitoring of the flow in the upstream catchment may be used as an aid to predict high flow events.

Works in Craughwell and reduction of flooding risk can be facilitated by phasing of the proposed works as detailed in the Programme.

No machinery shall be left in the river overnight or outside of normal working hours.

9 OPERATION OF THE PROPOSED FLOOD RELIEF SCHEME

When fully implemented, the proposed flood relief scheme will provide a defence against the 1 in 100 year flood event with allowance made for climate change. This will accommodate November 2009 flood flows.

However, the Dunkellin River channel will require regular maintenance to prevent vegetation becoming overgrown thus increasing the risk of future flooding. This will be managed by Galway County Council as part of their overall maintenance responsibilities for the Dunkellin Drainage District

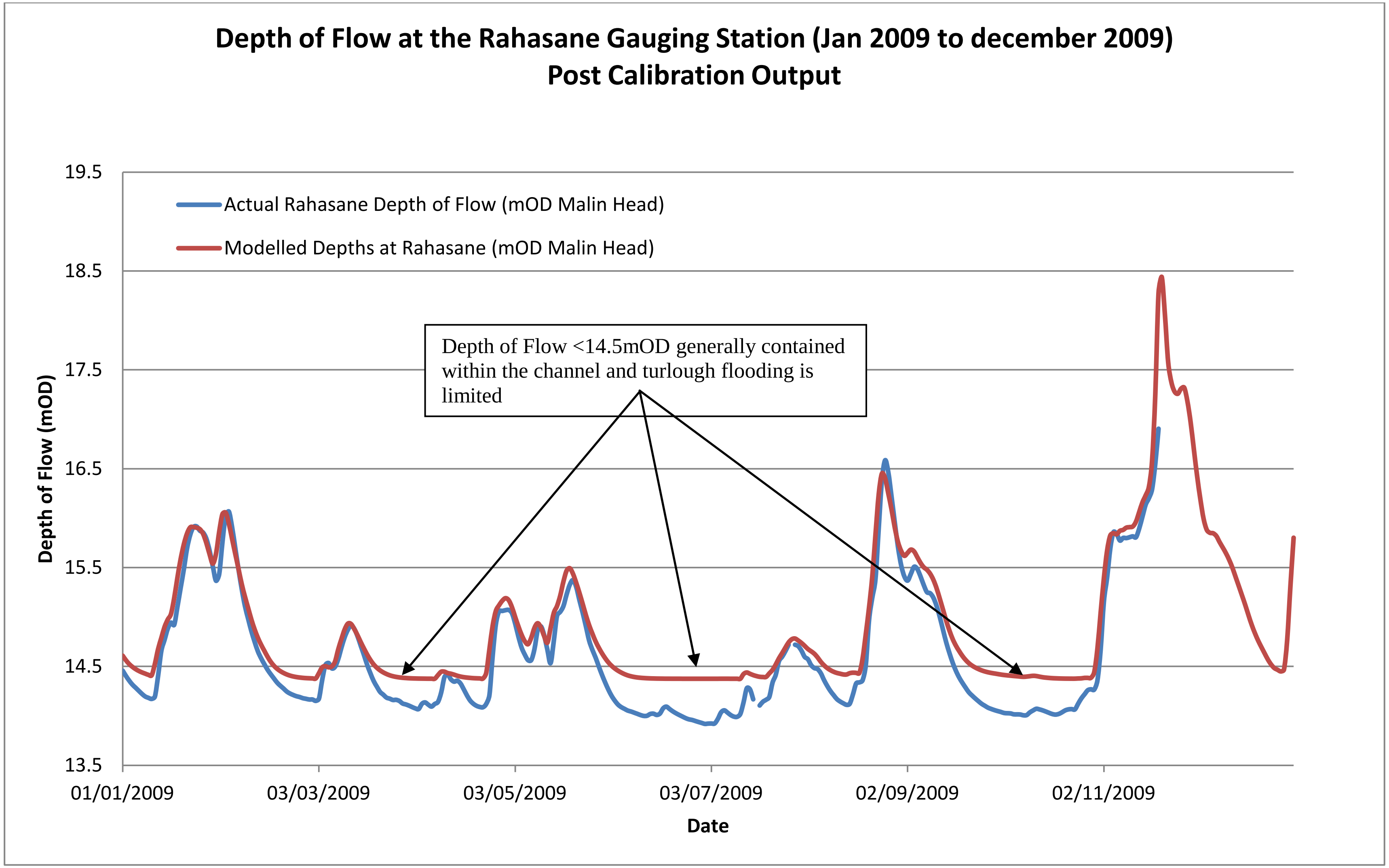
Galway County Council propose to undertake maintenance over a 5 year maintenance programme with activities being carried out as follows:

On a 5 year basis

- Light trimming of vegetation
- Non invasive cleaning of the river to remove excess silt or debris which may have gathered in the river.

Appendix No. 1

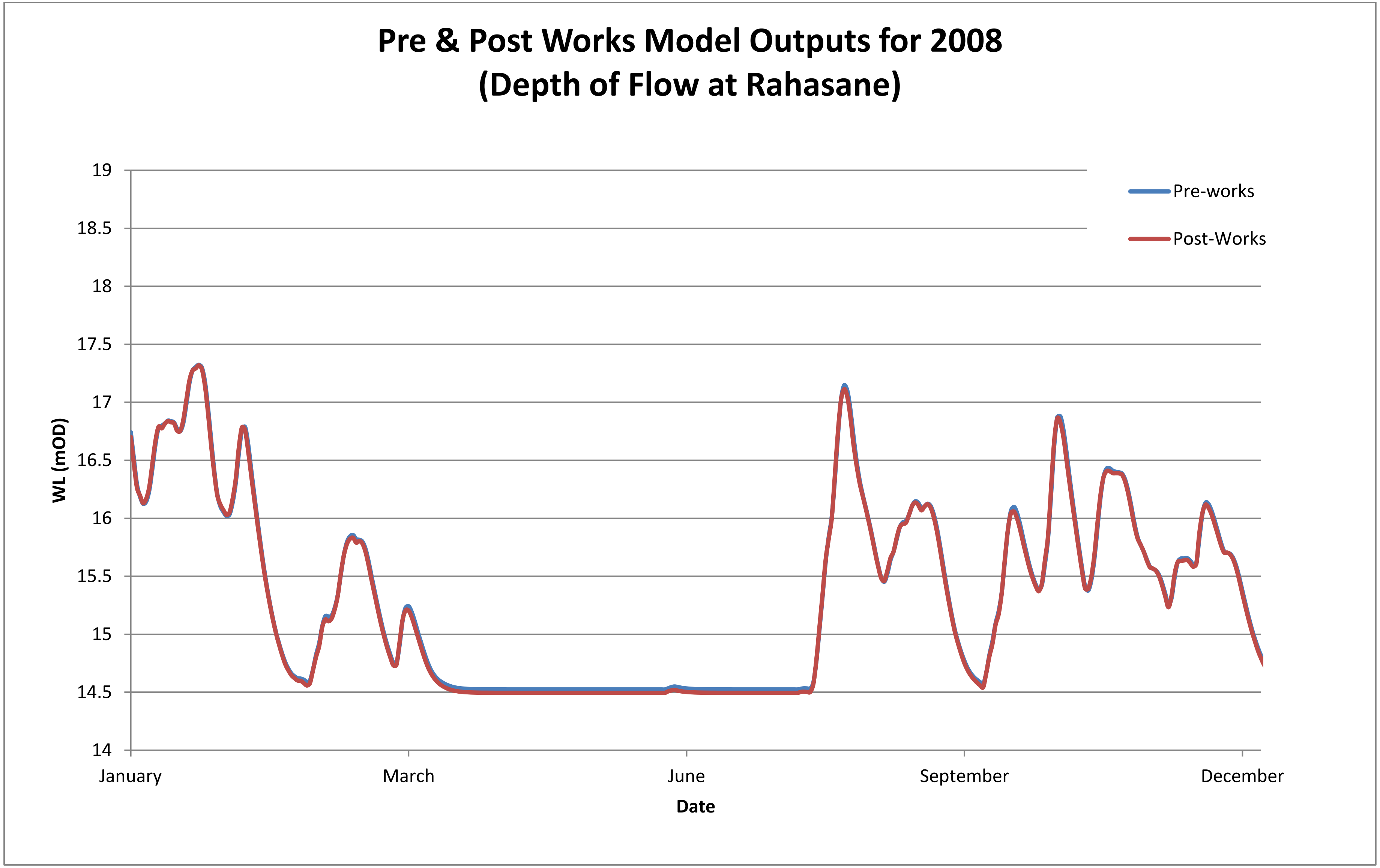
Calibrated Output from the Mathematical Model

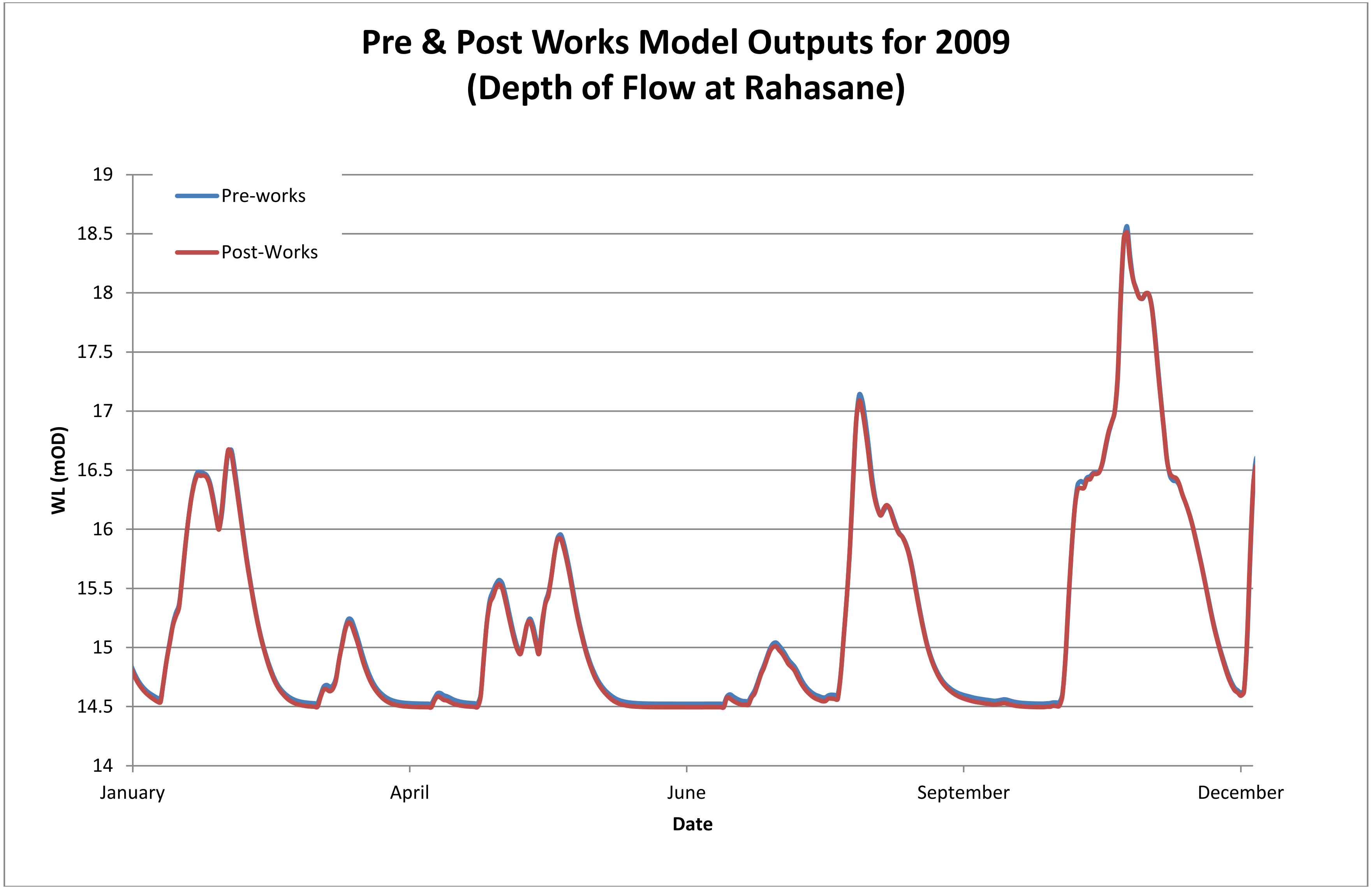


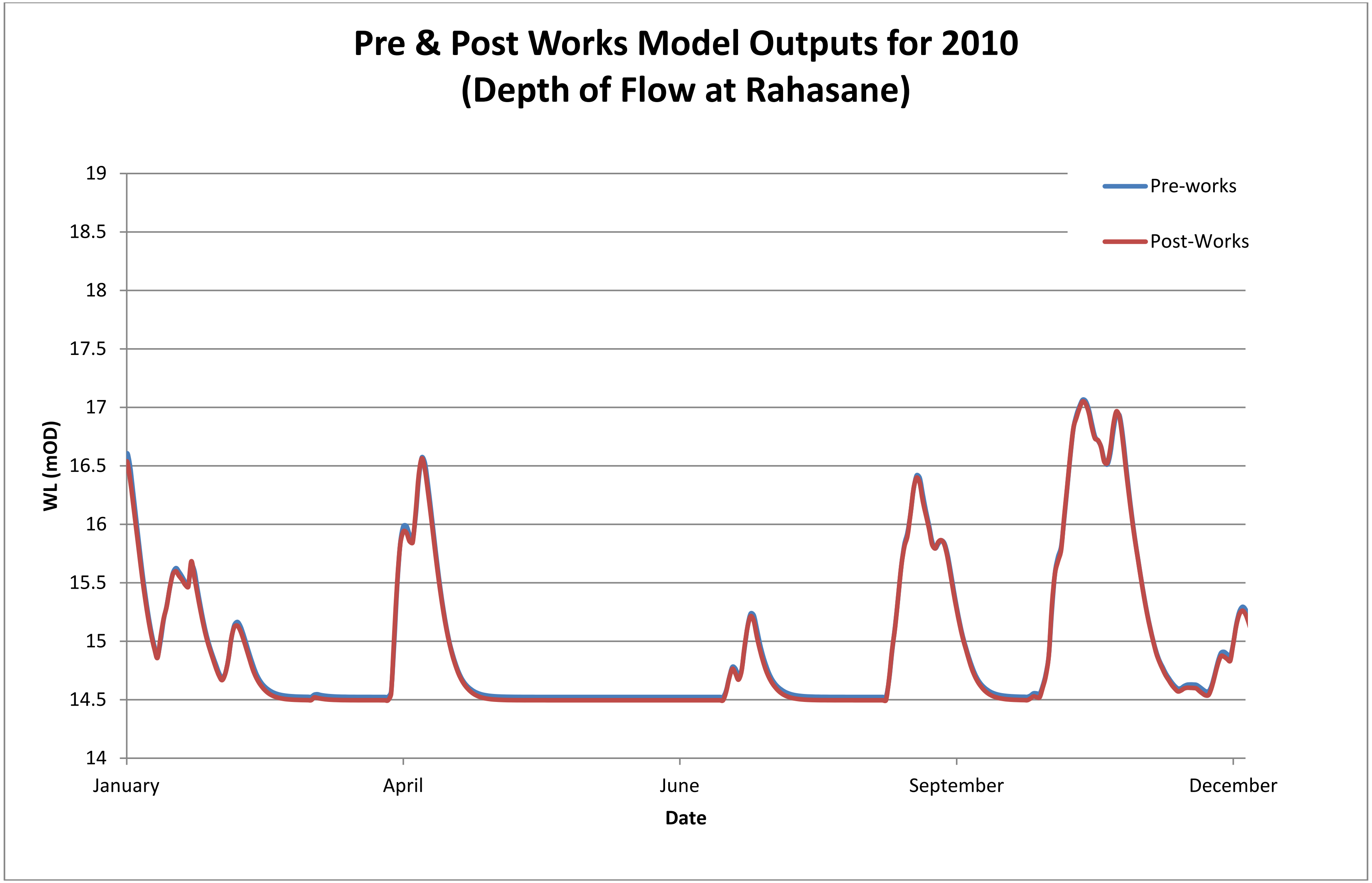
Depth of Flow at the Rahasane Gauging Station (Jan 2009 to december 2009)
Post Calibration Output
Actual Rahasane Depth of Flow (mOD Malin Head)
Modelled Depths at Rahasane (mOD Malin Head)
Depth of Flow <14.5mOD generally contained within the channel and turlough flooding is limited
Depth of Flow (mOD)
19.5
18.5
17.5
16.5
15.5
14.5
13.5
01/01/2009
03/03/2009
03/05/2009
03/07/2009
02/09/2009
02/11/2009
Date

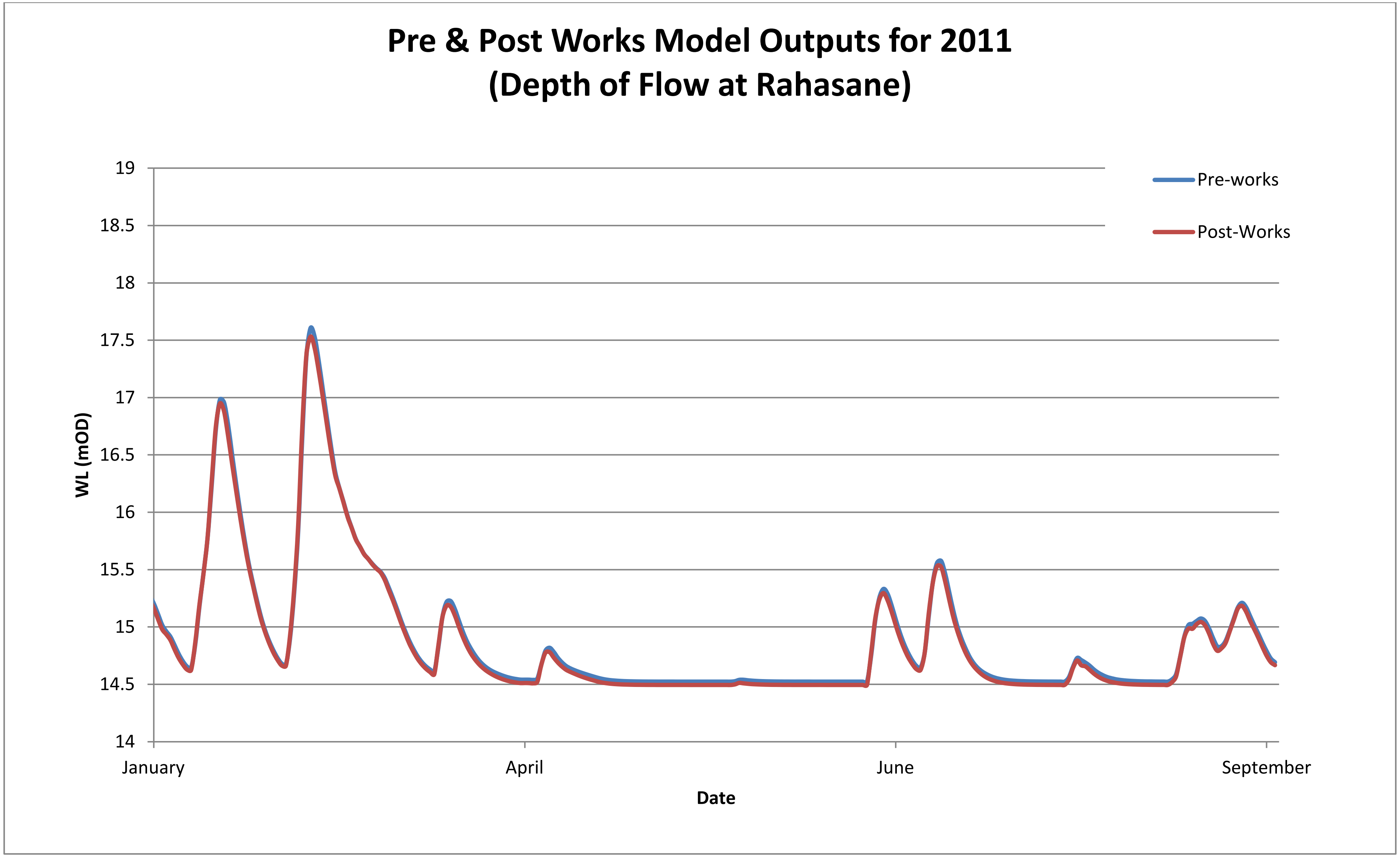
Appendix No. 2

Predicted Pre and Post Works Depth of Flow Output from the HEC-RAS Model


Pre & Post Works Model Outputs for 2008
(Depth of Flow at Rahasane)
19
18.5
18
17.5
17
16.5
16
15.5
15
14.5
14
WL (mOD)
January
March
June
September
December
Date
Pre-works
Post-Works


Pre & Post Works Model Outputs for 2009
(Depth of Flow at Rahasane)
Pre-works
Post-Works
WL (mOD)
19
18.5
18
17.5
17
16.5
16
15.5
15
14.5
14
January
April
June
September
December
Date

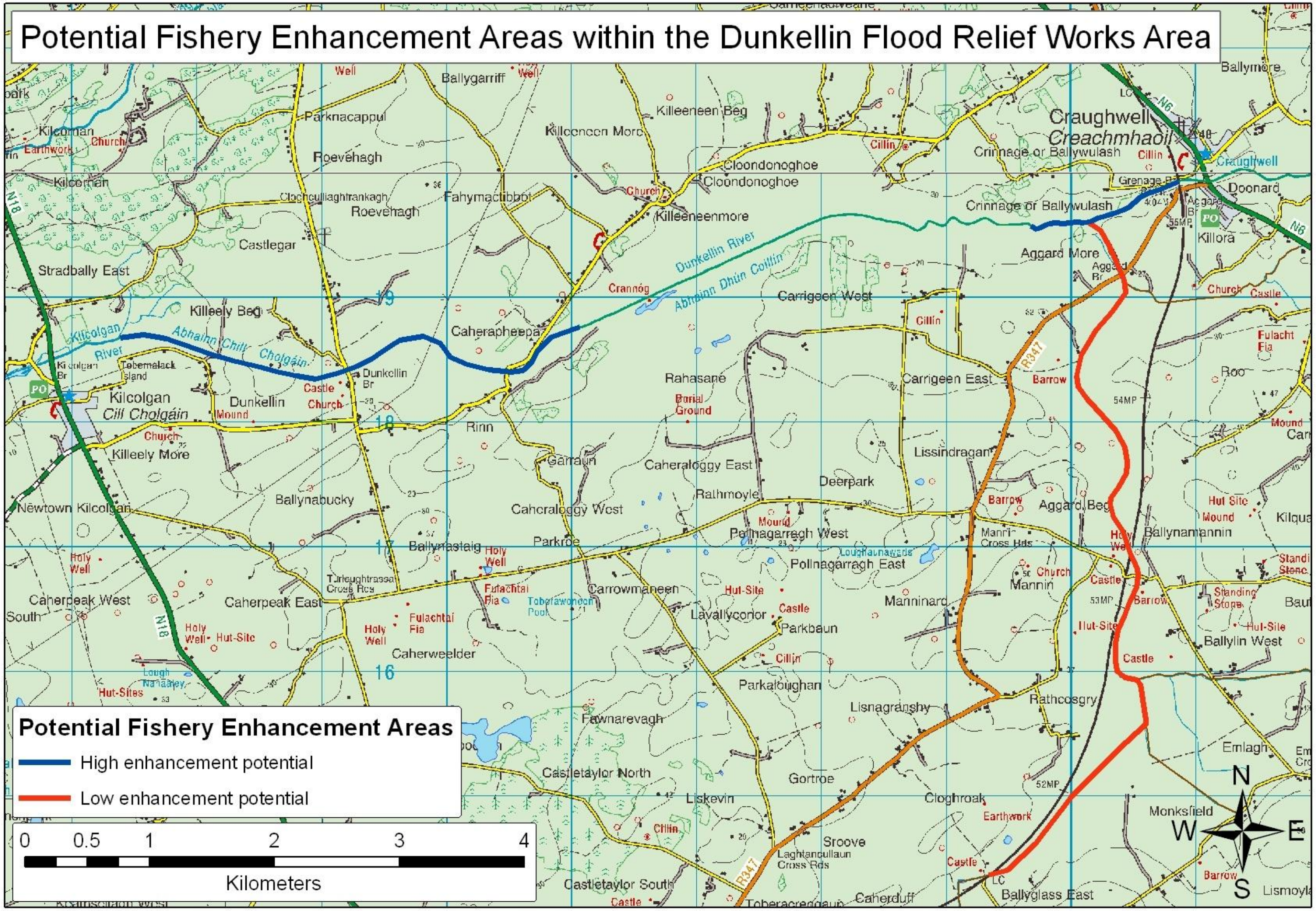

Pre & Post Works Model Outputs for 2010
(Depth of Flow at Rahasane)
Pre-works
Post-Works
WL (mOD)
19
18.5
18
17.5
17
16.5
16
15.5
15
14.5
14
January
April
June
September
December
Date


Pre & Post Works Model Outputs for 2011
(Depth of Flow at Rahasane)
19
18.5
18
17.5
17
16.5
16
15.5
15
14.5
14
WL (mOD)
January
April
June
September
Date
Pre-works
Post-Works

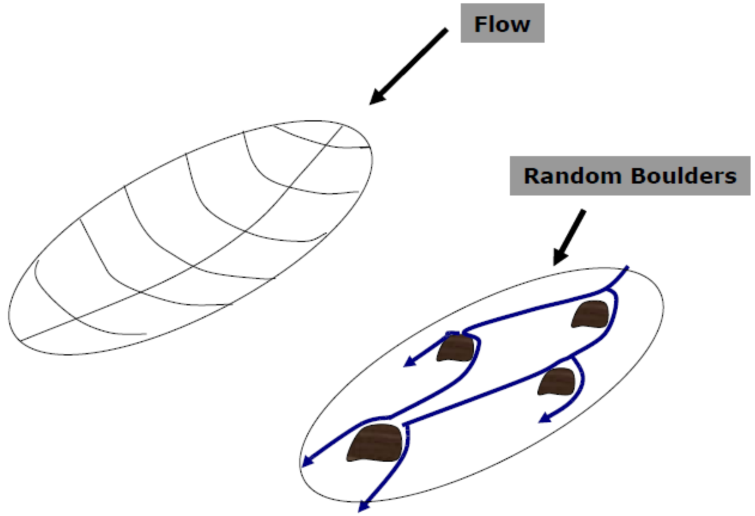
Appendix No. 3

Outline Typical Details of Proposed River Enhancement Works along the Dunkellin River as provided by Inland Fisheries Ireland

(Final Design & Location to be confirmed at Detailed Design Stage)


Potential Fishery Enhancement Areas within the Dunkellin Flood Relief Works Area
Potential Fishery Enhancement Areas
High enhancement potential
Low enhancement potential
0 0.5 1 2 3 4
Kilometers
N
S
E
W
Dunkellin River
Abhainn Dhún Coillín
Kilcolgan River
Abhainn Chill Cholgáin
Kilcolgan
Cill Cholgáin
Craughwell
Creachmhaoil

Detail 1. Centre Channel Pool



Key Features

Pool should be egg-shaped.

Pool Length 1.5 times channel width.

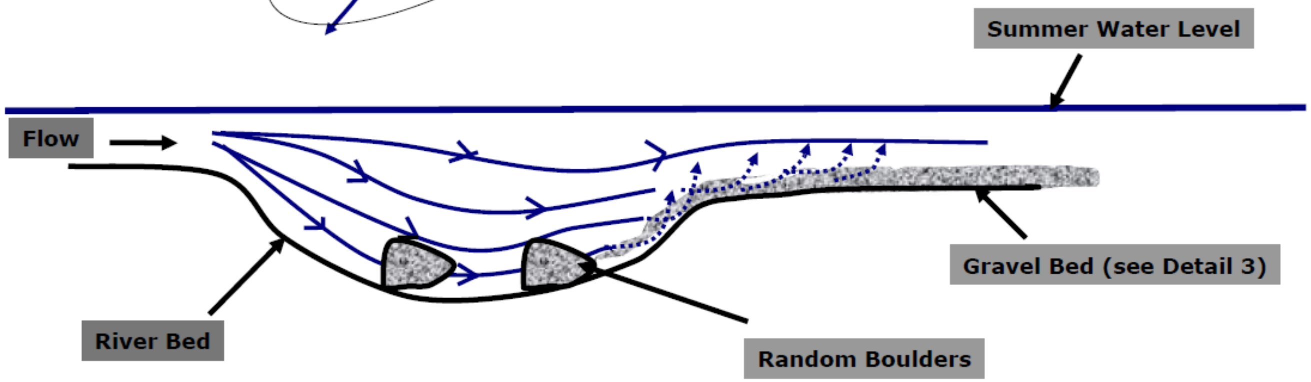
Gradually slope down to the deepest point (1.5m) in the centre and taper back up towards the tail.

Should also taper down from either side towards the centre.

Should occupy the central 2/3 area of the channel cross section.

Place a number of boulders in the pool.
Boulders should be placed in a triangular or diamond shaped pattern

Pool should be placed on average 5-7 channels widths in distance apart



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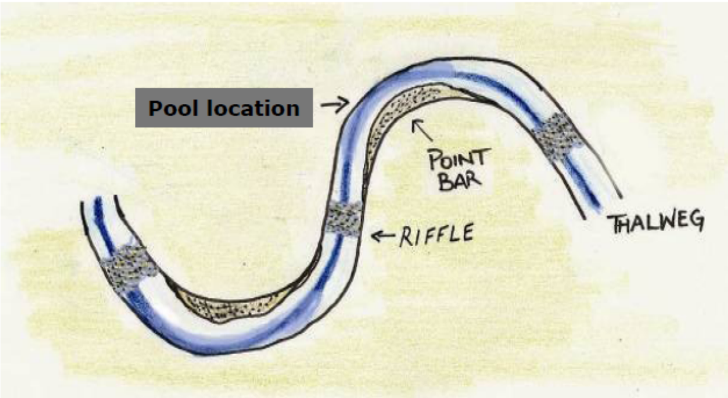
Inland Fisheries Ireland

Detail 2. Lateral Scour Pool



Key Features

Pool should be placed on the **eroding side of bends** in a meadering channel.

Pool should be banana-shaped.

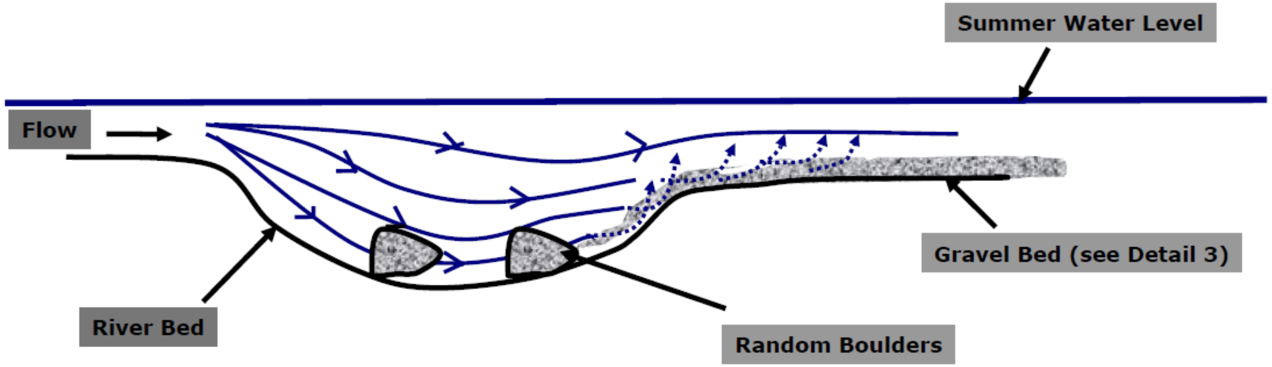
Pool length 1.5 times channel basewidth.

Pool width approximately 1/3 of the channel basewidth placed on eroding side of channel.

Gradually slope down to the deepest point (1.5m) in the centre of the pool and taper back up towards the tail.

Should also taper down from either side width deepest point leaning towards the eroding bank.

Place a number of boulders in the along the pool.



Detail 3. Gravel Placement

Key Features

Pool and gravel bed should be approx same length (1.5 times channel width).

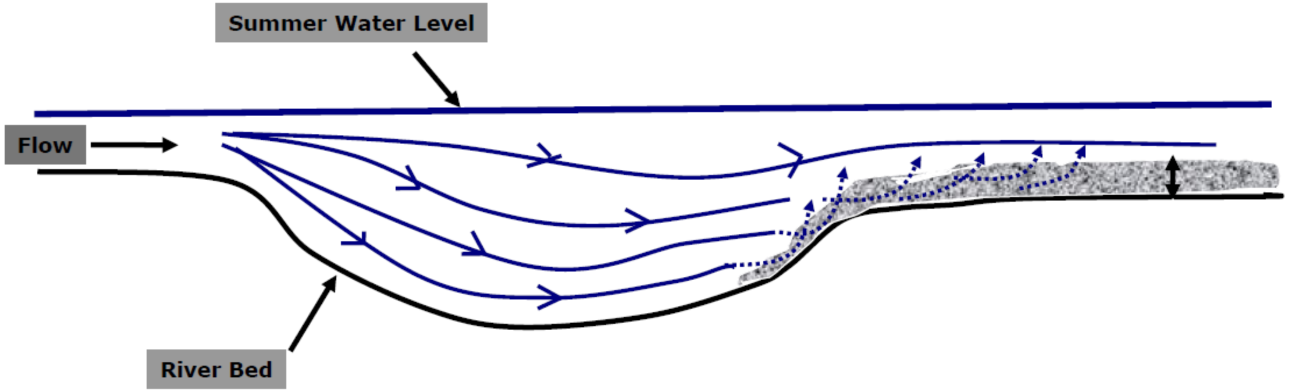
Should occupy the central 2/3 area of the channel cross section.

Start to place gravel at tail of pool (downstream end).

Gravel bed should be 35 to 40cm deep.

Gravel Size (see Detail 4 spawning gravels).

Up-welling of water through the gravels is essential.



Detail 4. Spawning Gravel

Table 4.1

Type	Grade	% Composition
Cobble	64 - 190mm	10%
Very coarse gravel	32 - 64mm	35%
Coarse gravel***	16 – 32mm	25%
Medium gravel***	8 - 16mm	20%
Fine gravel***	4 – 8mm	10%

Table 4.2

Type	Grade	% Composition
Cobble	64 - 190mm	0%
Very coarse gravel	32 - 64mm	15%
Coarse gravel***	16 – 32mm	35%
Medium gravel***	8 - 16mm	30%
Fine gravel***	4 – 8mm	15%

Key Features

Wide variation in particle size.

Washed, rounded stones.

See table 4.1 below for range and % composition of stones required for **Irish salmon** and **sea trout** spawning gravels.

See table 4.2 below for range and % composition of stones required for **brown trout** spawning gravels.

***Least critical component of this mix as they will settle naturally once the cobble and very coarse gravel is placed.

Ratio of cobble to very coarse gravel to be placed - 50:50 .

For placement of gravel see Detail 3.

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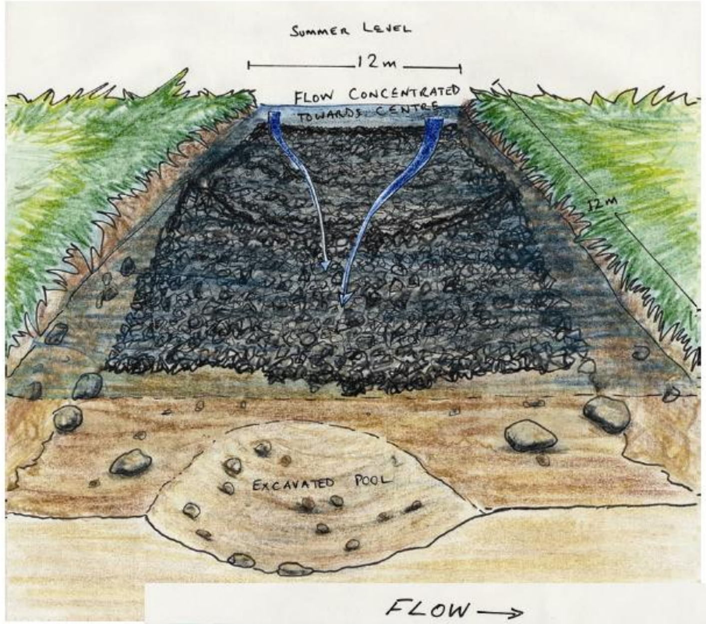
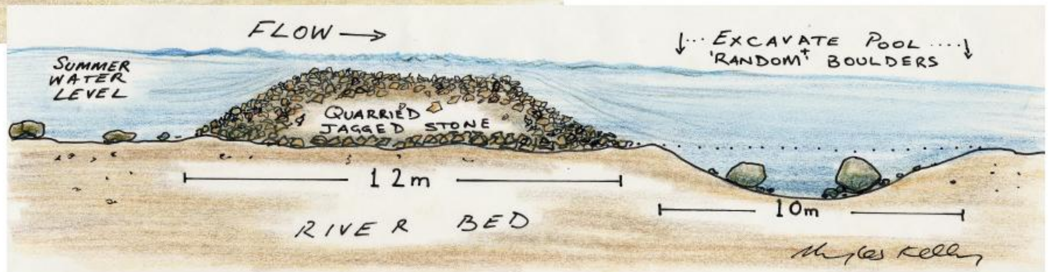
Detail 5. Rubble Mat





Key Features

Broken quarried stone (150 - 250mm).

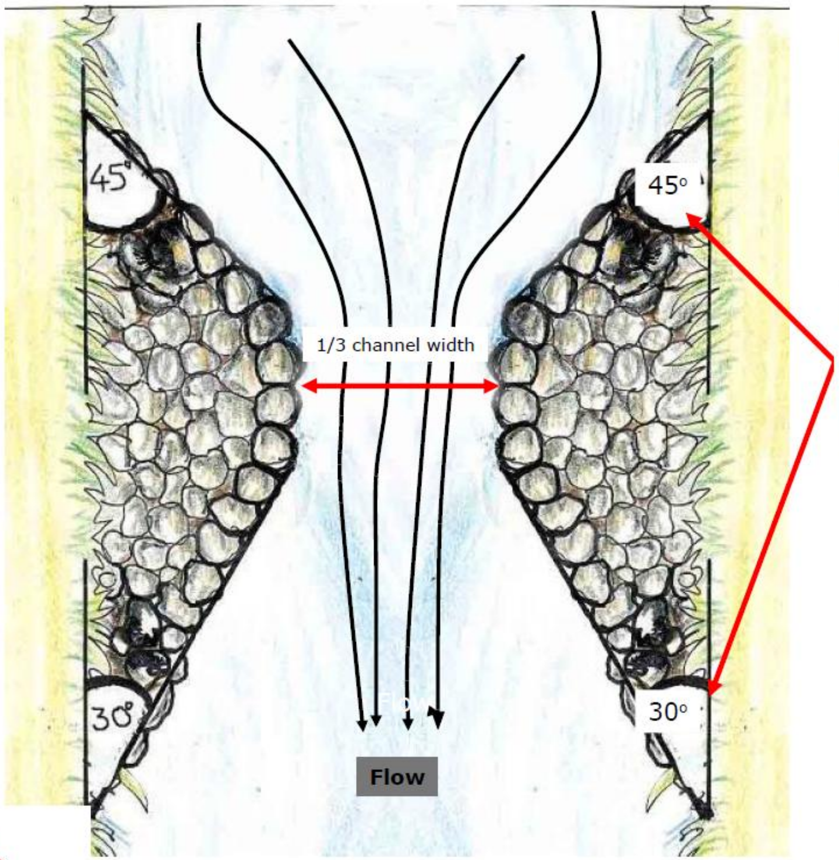
Rubble mat Length equal to one channel width.

Stone placed below summer low water level from bank to bank.

Gulley should be made through the rubble mat concentrating flow towards centre of channel.

Excavate pool downstream of rubble mat (Detail 1)

Detail 6. Paired Stone Deflectors



Key Features

The largest heaviest stones available should be used at the outer tip of each deflector where the maximum erosive pressure will be generated by river flows.

Outer stones should be buried a little more than the others as the structure must slope out and down from the bank, ie. the stones at the outer tip of the deflector need to be at the lowest point of the structure.

The outer tip of each deflector should be no higher than summer water level.

45° angle on upstream slope and 30° angle on downstream slope (as detailed in drawing) required to generate appropriate flow regime.

Detail 7. Alternating Stone Deflectors

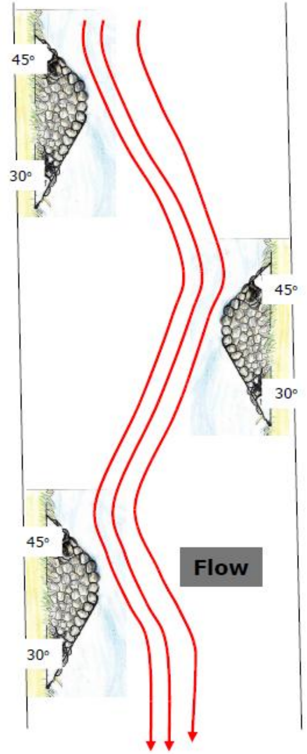


Figure 7.1

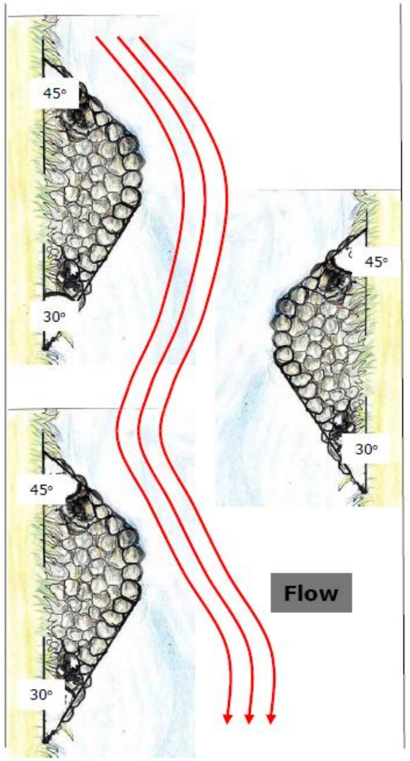


Figure 7.2

Key Features

The largest heaviest stones available should be used at the outer tip of each deflector where the maximum erosive pressure will be generated by river flows.

Outer stones should be buried a little more than the others as the structure must slope out and down from the bank, ie. the stones at the outer tip of the deflector need to be at the lowest point of the structure.

The outer tip of each deflector should be no higher than summer water level.

45° angle on upstream slope and 30° angle on downstream slope required to generate appropriate flow regime.

In fast-flowing channels, deflectors do not overlap (figure 7.1).

In slow-flowing, wide channels, deflectors may overlap (figure 7.2)

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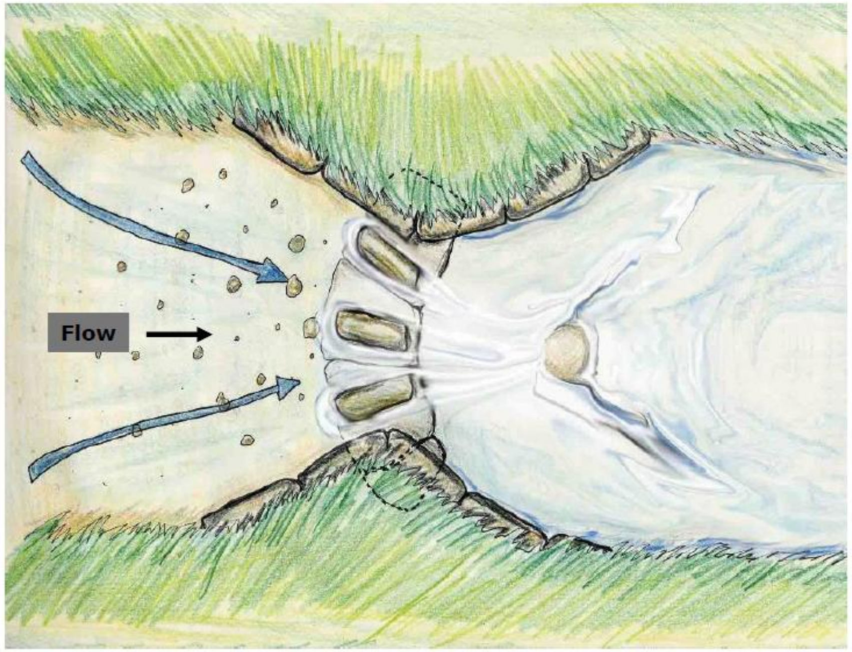
Detail 8. Vortex Stone Weir



Key Features

A series of rocks are built into both backs to direct flow towards centre of channel.

A line of footer stones, arched upstream are buried across the central channel area. The surface of these stones should be flush with the bed of the stream.

Three rocks are placed on top of the footer stones. The top of these rock are exposed by a few centimetres in summer low flow and are fully sumberged in high flows.

Excavate a pool dowmstream of the weir (see Detail 1 Centre Channel Pool)

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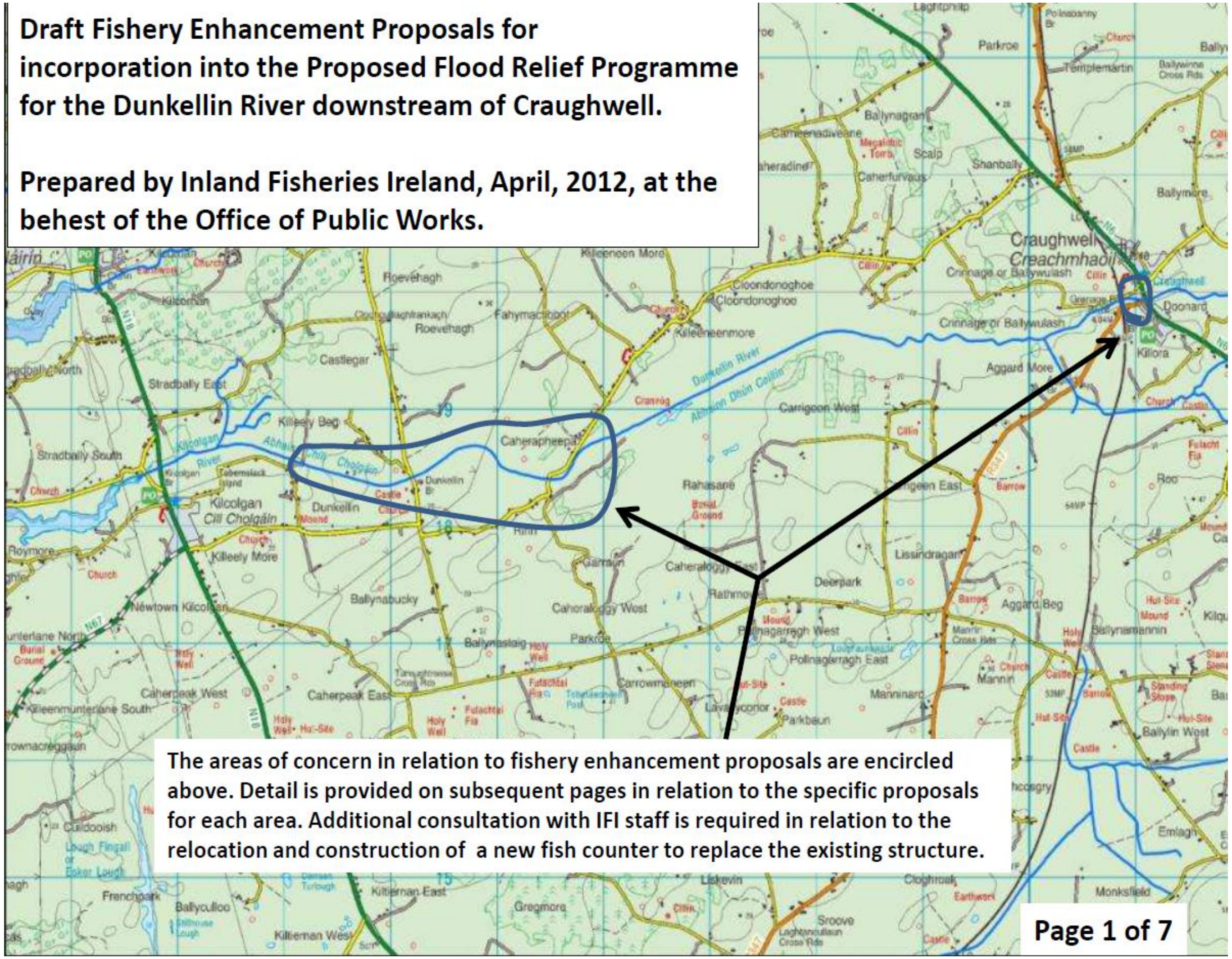
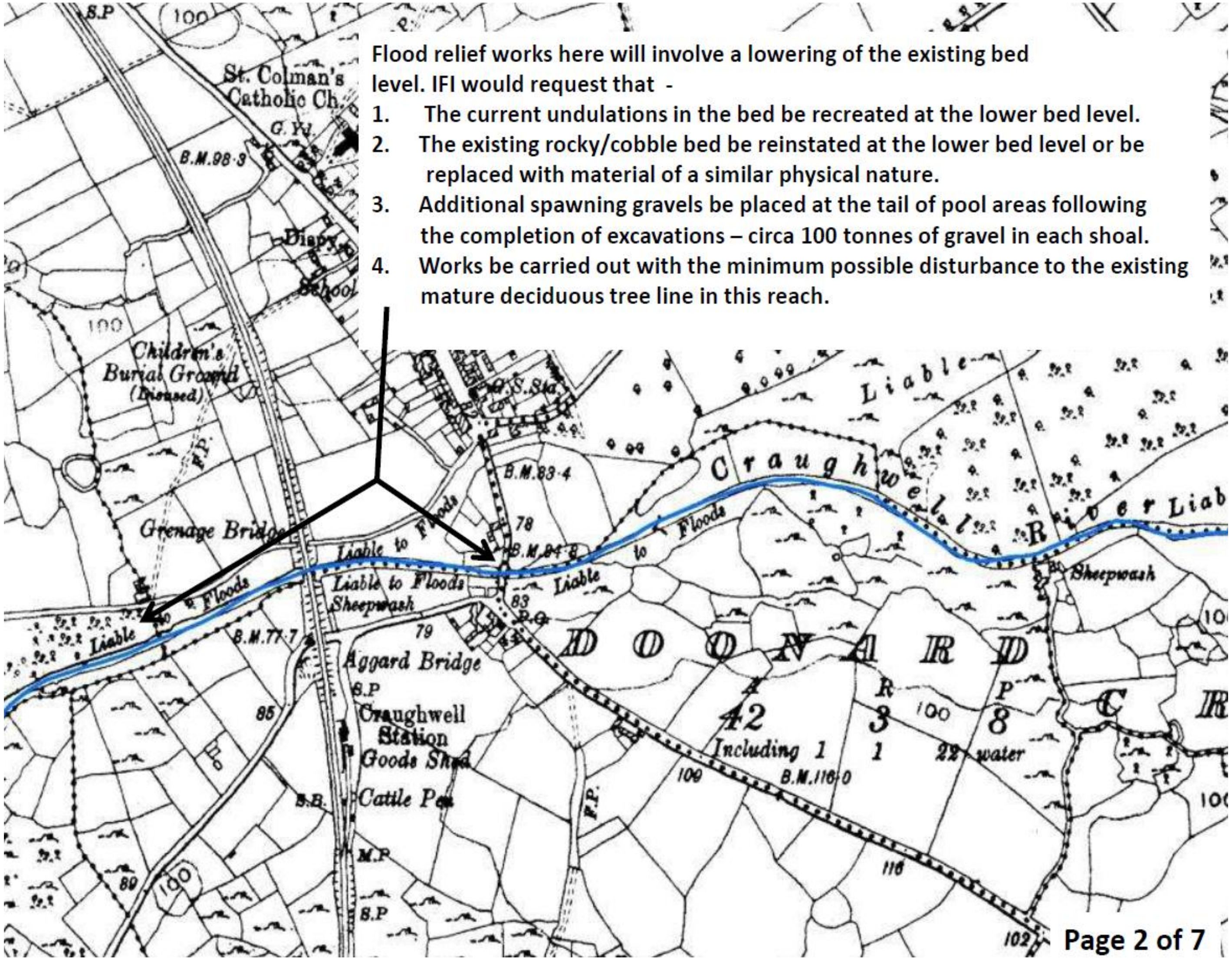
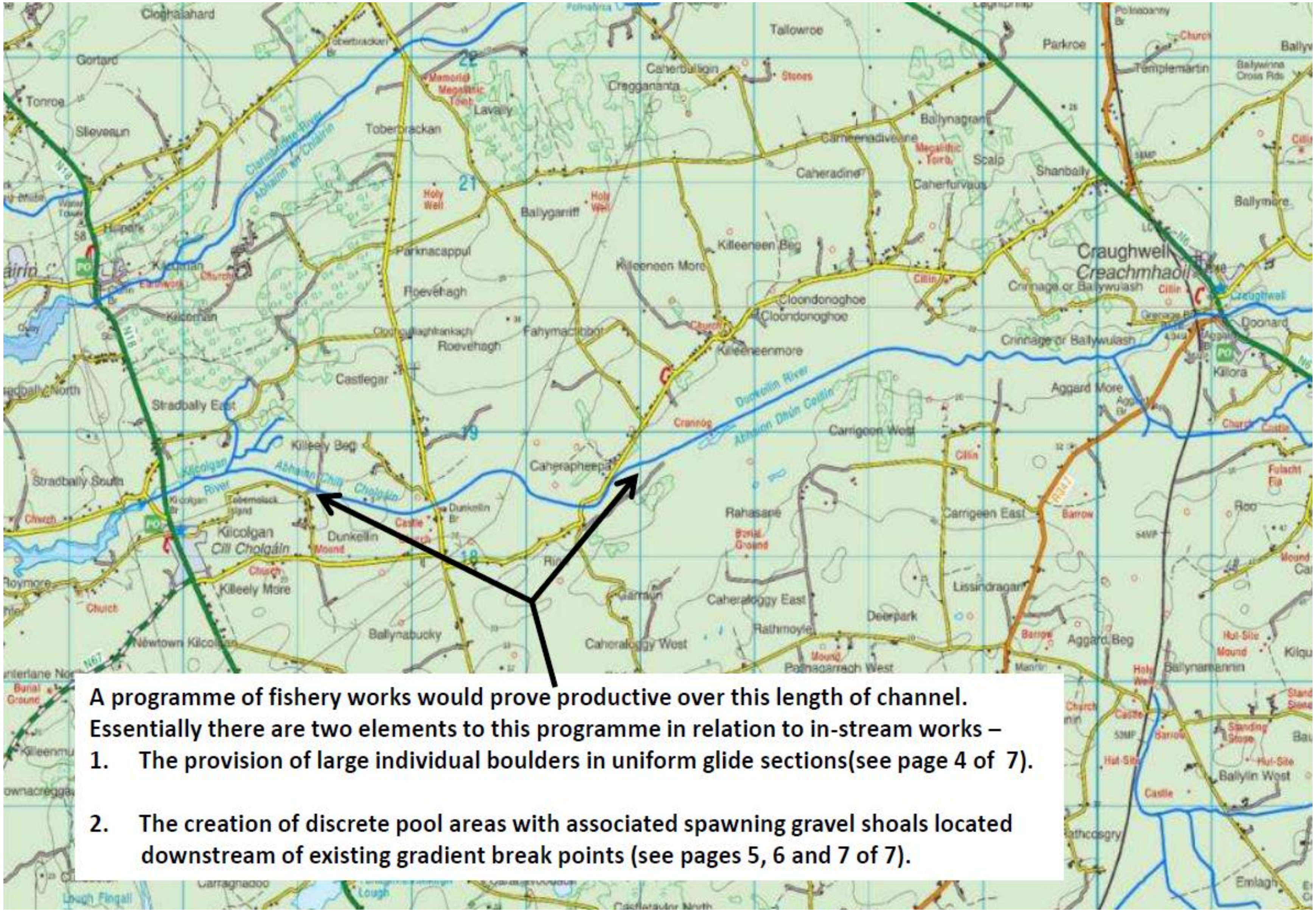

Draft Fishery Enhancement Proposals for incorporation into the Proposed Flood Relief Programme for the Dunkellin River downstream of Craughwell.
Prepared by Inland Fisheries Ireland, April, 2012, at the behest of the Office of Public Works.
The areas of concern in relation to fishery enhancement proposals are encircled above. Detail is provided on subsequent pages in relation to the specific proposals for each area. Additional consultation with IFI staff is required in relation to the relocation and construction of a new fish counter to replace the existing structure.
Page 1 of 7
Craughwell
Creachmhaoil
Dunkellin River
Kilcolgan
Cill Cholgáin
Dunkellin
Caherapheepa
Rahasane
Killeely More
Killeely Beg
Castlegar
Roevehagh
Stradbally East
Stradbally South
Ballynabucky
Carrigeen West
Aggard More
Aggard Beg
Kilcornan
Newtown Kilcolgan
Caherpeak West
Caherpeak East
Carrowmaneen
Lissindragan
Deerpark
Parkroe
Templemartin
Shanbally
Killora
Doonard
Ballymore
Crinnage or Ballywulash
Cloondonoghoe
Killeeneenmore
Pollnagarragh East
Monksfield
Kiltiernan East
Gregmore
Killeeneen More

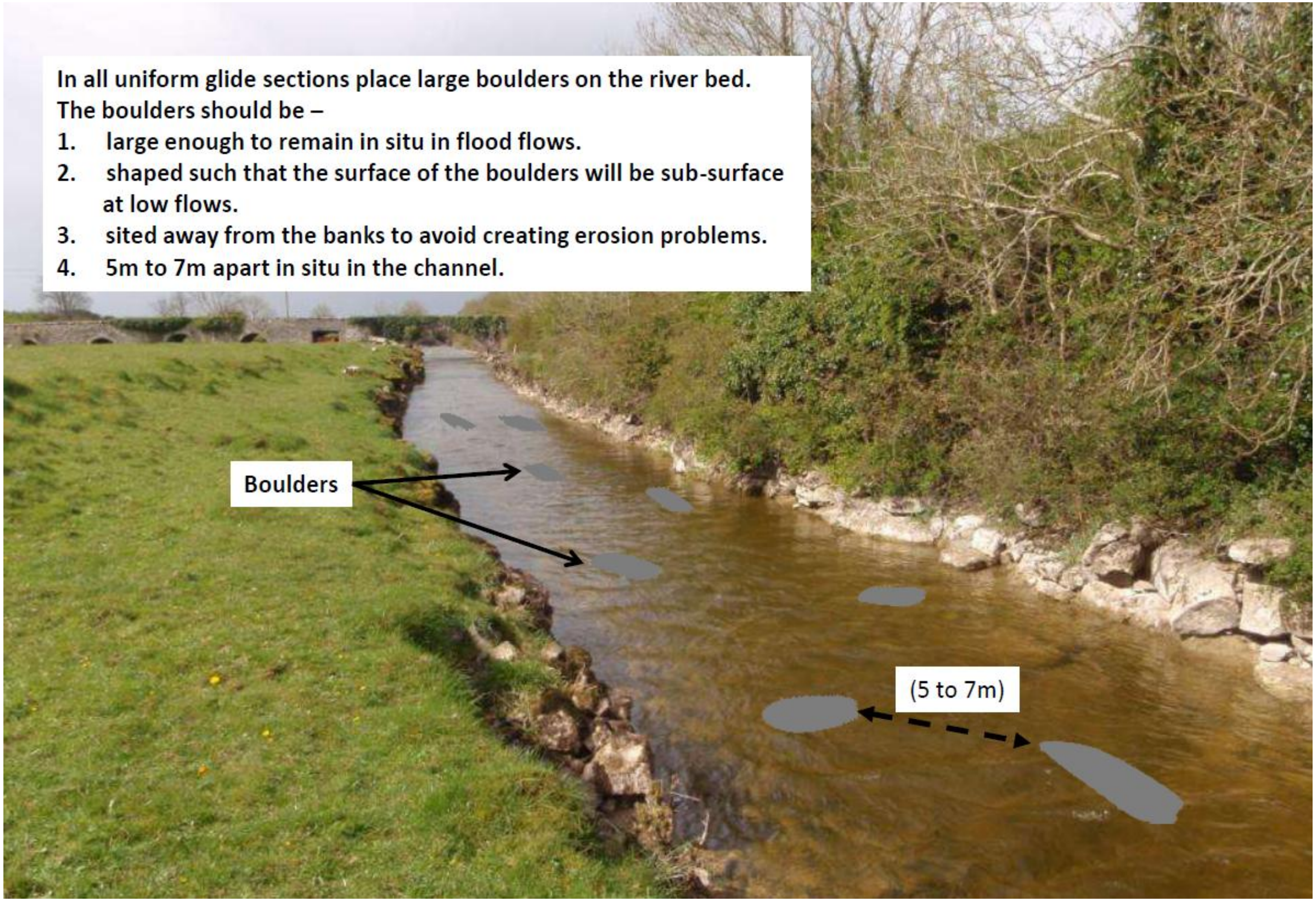

Flood relief works here will involve a lowering of the existing bed level. IFI would request that -
1. The current undulations in the bed be recreated at the lower bed level.
2. The existing rocky/cobble bed be reinstated at the lower bed level or be replaced with material of a similar physical nature.
3. Additional spawning gravels be placed at the tail of pool areas following the completion of excavations – circa 100 tonnes of gravel in each shoal.
4. Works be carried out with the minimum possible disturbance to the existing mature deciduous tree line in this reach.
St. Colman's Catholic Ch.
G. Yd.
B.M.98·3
Dispy.
School
Children's Burial Ground (Disused)
Grenage Bridge
Liable to Floods
Sheepwash
B.M.77·7
79
Aggard Bridge
S.P
Craughwell Station
Goods Shed
Cattle Pen
S.B.
M.P
85
89
B.M.83·4
78
B.M.84·8
83
P.O.
Craughwell River
Liable
Floods
DOONARD
42
3
8
Including 1
1
22 water
B.M.116·0
109
116
102
100
Sheepwash
F.P.
Page 2 of 7

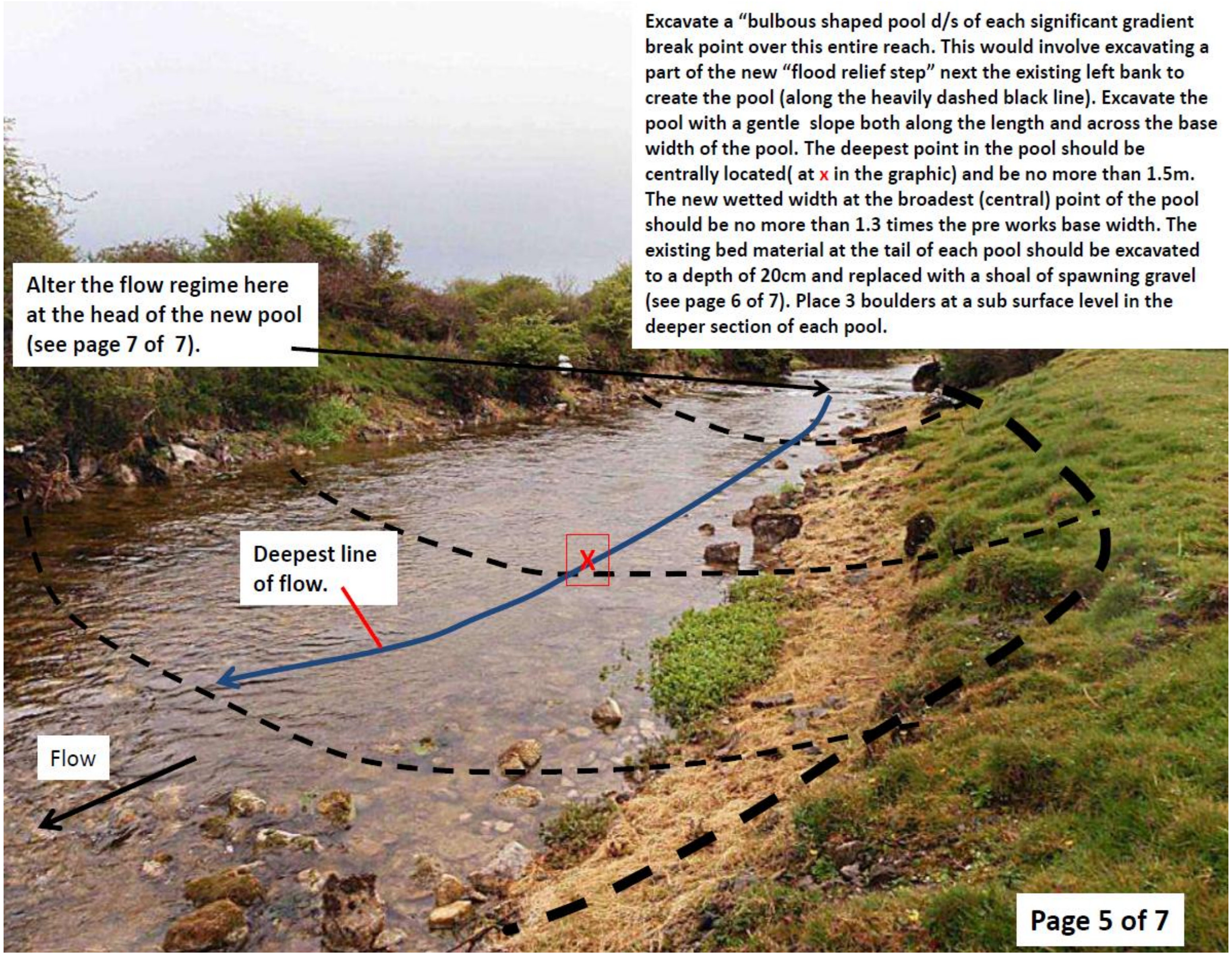


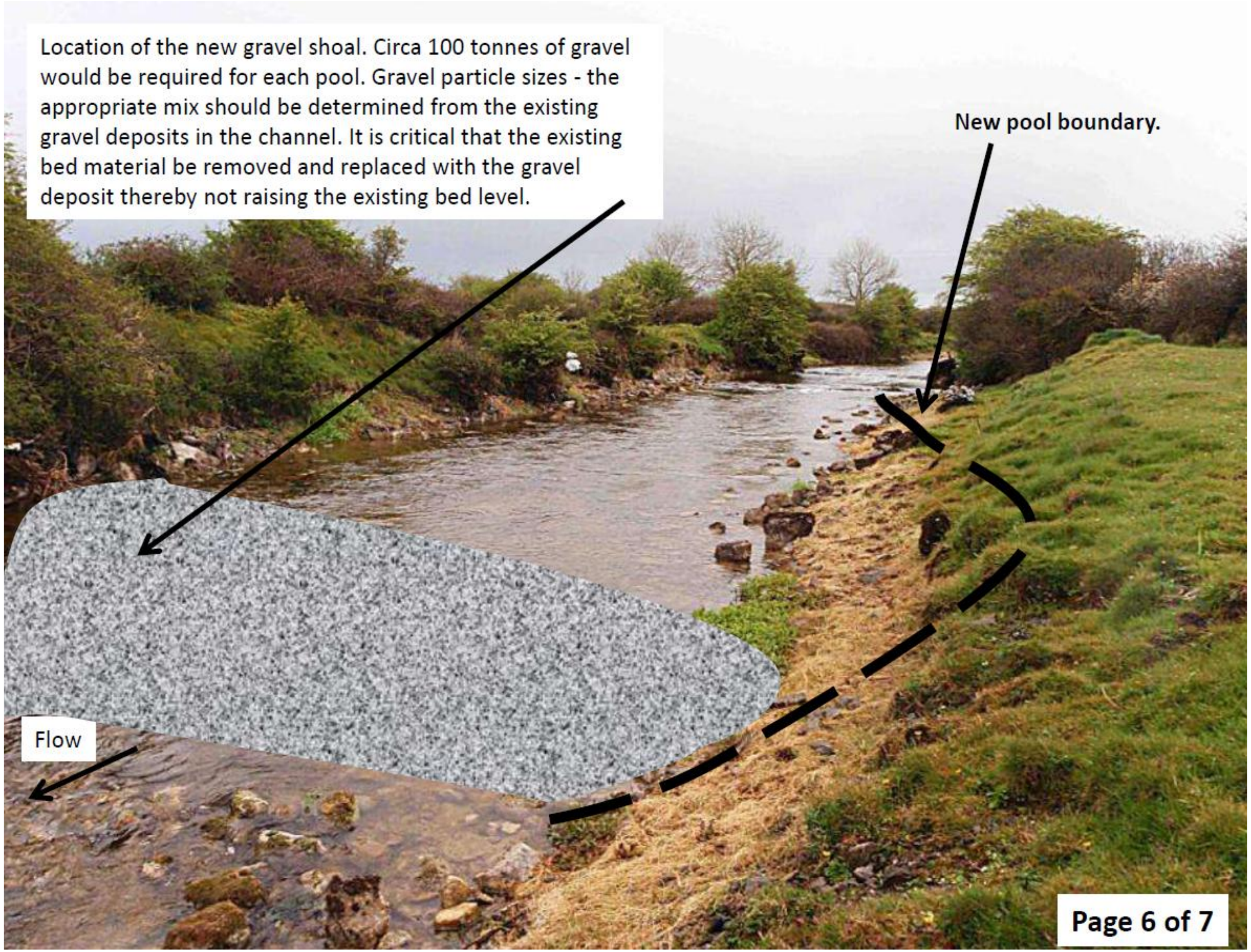
A programme of fishery works would prove productive over this length of channel.
Essentially there are two elements to this programme in relation to in-stream works –

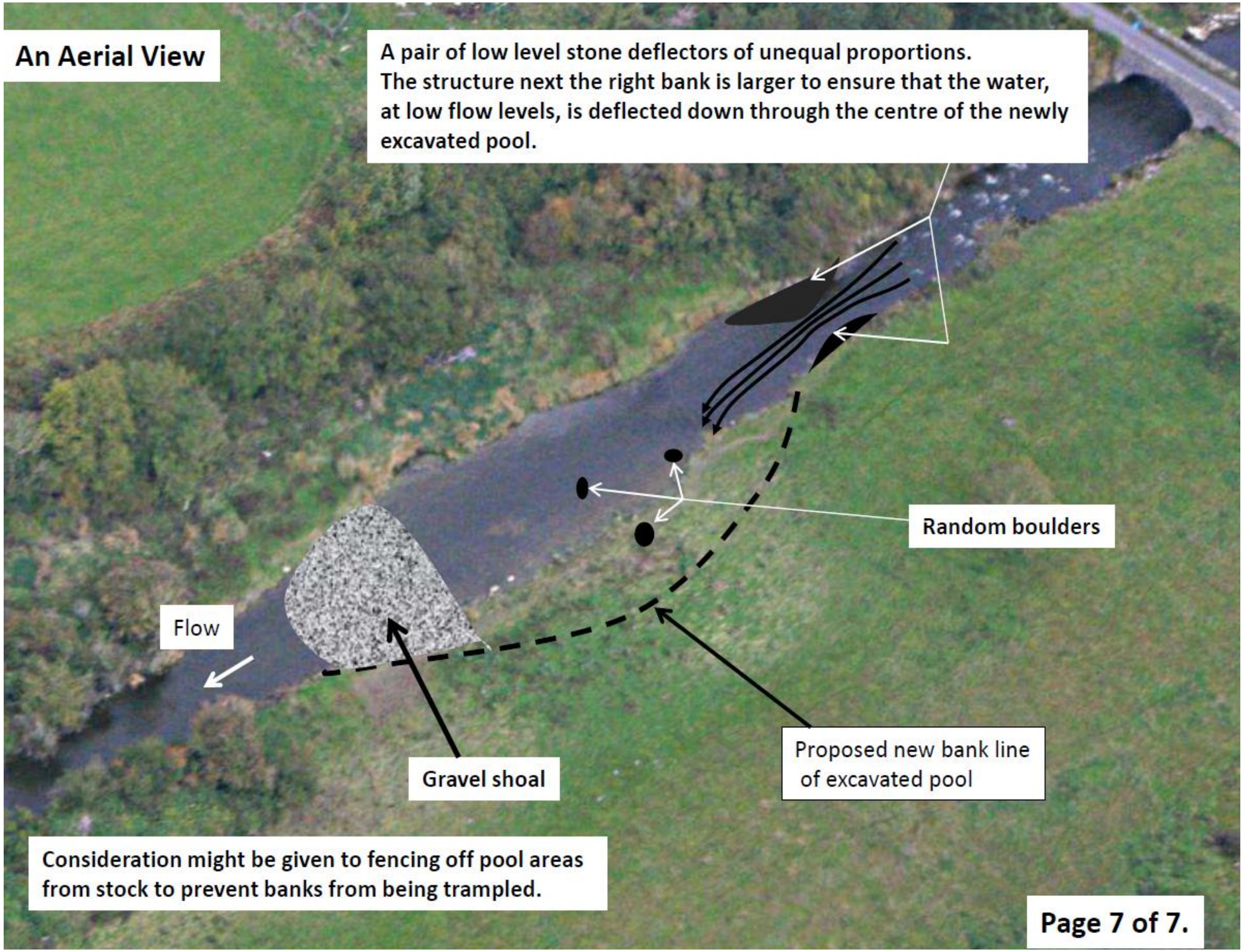
1. The provision of large individual boulders in uniform glide sections(see page 4 of 7).

2. The creation of discrete pool areas with associated spawning gravel shoals located downstream of existing gradient break points (see pages 5, 6 and 7 of 7).


In all uniform glide sections place large boulders on the river bed.
The boulders should be –
1. large enough to remain in situ in flood flows.
2. shaped such that the surface of the boulders will be sub-surface at low flows.
3. sited away from the banks to avoid creating erosion problems.
4. 5m to 7m apart in situ in the channel.
Boulders
(5 to 7m)


Excavate a "bulbous shaped pool d/s of each significant gradient break point over this entire reach. This would involve excavating a part of the new "flood relief step" next the existing left bank to create the pool (along the heavily dashed black line). Excavate the pool with a gentle slope both along the length and across the base width of the pool. The deepest point in the pool should be centrally located(at x in the graphic) and be no more than 1.5m. The new wetted width at the broadest (central) point of the pool should be no more than 1.3 times the pre works base width. The existing bed material at the tail of each pool should be excavated to a depth of 20cm and replaced with a shoal of spawning gravel (see page 6 of 7). Place 3 boulders at a sub surface level in the deeper section of each pool.
Alter the flow regime here at the head of the new pool (see page 7 of 7).
X
Deepest line of flow.
Flow
Page 5 of 7


Location of the new gravel shoal. Circa 100 tonnes of gravel would be required for each pool. Gravel particle sizes - the appropriate mix should be determined from the existing gravel deposits in the channel. It is critical that the existing bed material be removed and replaced with the gravel deposit thereby not raising the existing bed level.
New pool boundary.
Flow
Page 6 of 7


An Aerial View
A pair of low level stone deflectors of unequal proportions.
The structure next the right bank is larger to ensure that the water,
at low flow levels, is deflected down through the centre of the newly
excavated pool.
Random boulders
Flow
Gravel shoal
Proposed new bank line
of excavated pool
Consideration might be given to fencing off pool areas
from stock to prevent banks from being trampled.
Page 7 of 7.

FURTHER DETAIL OF RIVER ENHANCEMENT WORKS AT CRAUGHWELL (IFI Proposals)

An Ecological Evaluation of the likely impacts of a proposed flood relief scheme on a reach of the Craughwell River at Craughwell, Co. Galway.

1.The Flood Relief Proposal

Details of this flood relief proposal are provided in Figure 1.Proposed works involve a continuous deepening of the existing channel from a point 160 metres upstream of Craughwell Village downstream to a point 912 metres below the village. No widening of any channel section within this reach is proposed. The proposal will incorporate a fishery enhancement "layer" designed to protect fish stocks and also improve general ecological diversity in the river corridor. To accommodate these objectives the design incorporates a deepening of dredging operations by 0.5m below the flood relief design bed level to allow one to provide morphological diversity (riffle/glide/pool sequences) in the channel post-dredging where possible.

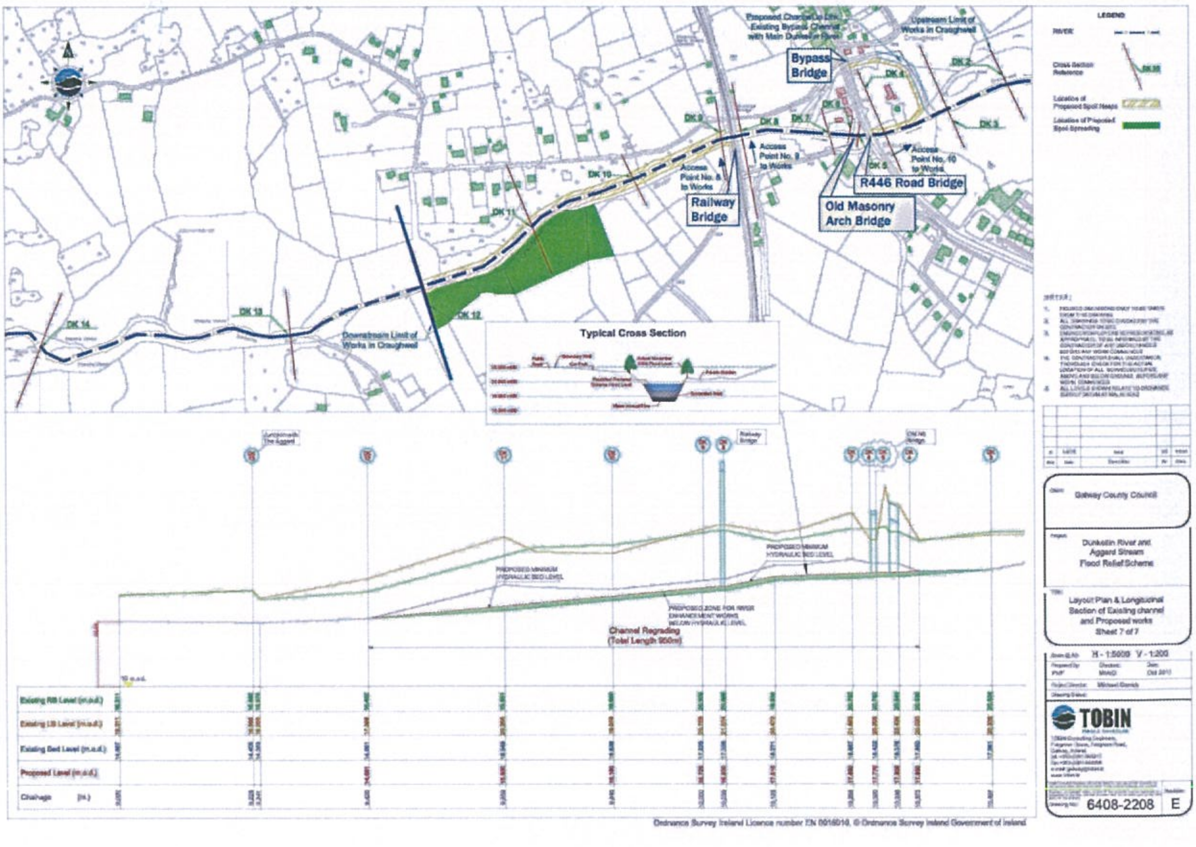


Figure 1. Detail in relation to the flood relief proposal.

2.The Current Status of this Channel Reach from a fluvial geomorphological and ecological perspective.

In fluvial geomorphological terms the Craughwell River would be classified as a "C Type" channel (after Rosgen, 1996). An undisturbed "C Type" channel would have well defined pool areas, on average, at intervals of 7 channel widths in distance apart with associated gravelled riffle areas adjacent to each pool. One would expect to find shallow glide areas between the pools. The current physical form of the Craughwell River reach in question does not fit this description. Clearly at some time in the past this river reach was dredged and partially canalised. Currently most reaches are either deep flats or uniform shallow glides. There is only one significant gravelled riffle throughout the entire reach (see Fishery Enhancement Plan, page 3).

In summary the existing channel can be described as;-

- having very little salmonid and lamprey spawning habitat.
- a dearth of well-defined pool areas which means that;-
  a – adult trout habitat is very limited.
  b – resting places for adult salmon and sea trout returning to spawn are restricted.
  c – significant fine silt deposits which would normally be found along the margins of well defined pool areas are not present which means that this reach currently cannot accommodate a significant juvenile lamprey population.
- the dearth of gravelled riffles will also limit the diversity of both the aquatic flora and macroinvertebrate fauna.
- the overall biological productivity of this river zone, downstream of the village, is limited because of excessive shading – currently significant river bed areas are devoid of algal, moss and macrophytic plant colonies because of excessive shade.

3.Likely Impacts of the Flood Relief Scheme once the Fishery Enhancement Proposals are Implemented as part of this Programme.

The incorporation of the fishery enhancement proposals (attached), as part of this flood relief scheme, will address some of the current morphological and ecological imbalances in this channel reach as outlined in Section 2.

- a total of 13 new pool areas with associated gravelled riffles will be in place – currently there is only one gravelled riffle and one well defined pool area in this entire zone.
- the fish carrying capacity of deeper glide areas will be enhanced by the proposed addition of random boulders.
- the proposed partial and targeted reduction in bankside vegetation will significantly improve the biological diversity and overall productivity of this channel reach for the aquatic flora, macroinvertebrate fauna and fish stocks.

The author has been involved in designing and monitoring the effectiveness of river enhancement programmes, like this proposal, for over 30 years. To-day there is a significant body of evidence to show that the projected long-term positive impacts of this programme, as outlined above, are the most likely outcome once the proposed fishery enhancement scheme is adopted as part of the programme (some of the authors relevant scientific publications in this area are appended).

Martin Ó Grady

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Senior Research Officer,

Inland Fisheries Ireland.

July 15th, 2014.

Some of the author's scientific publications of relevance to this document.

BYRNE, C., IGOE, F., COOKE, D., O'GRADY, M. and GARGAN, P. (1998) The Distribution of the Brook Lamprey (*Lampetra planeri*, Bloch) in the Lough Corrib Catchment in the West of Ireland and some aspects of its biology and ecology. Presented at the S.I.L. Conference, Dublin, August 1998.

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O'GRADY, M.F. (1994) The enhancement of salmonid runs in Ireland. I.W.E.M. Conference, London Zoo.

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O'GRADY, M.F. (1999) The restoration of salmonid habitats in Ireland. *Primera Semena del Salmon Atlantico en la Peninsula Iberica. Oviedo*, p.173-178.

O'GRADY, M.F. (2002) Salmonid Riverine Enhancement in Ireland, Past, Present and Future. Went Memorial Lecture. Annual Papers in Irish Science and Technology, No. 26, Royal Dublin Society.

O'GRADY, M.F. (2006) Channels and Challenges. Enhancing Salmonid Rivers. Irish Freshwater Fisheries Ecology and Management Services : Number 4, Central Fisheries Board, Dublin, Ireland. ISSN: 1649-265X.

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O'GRADY, M.F., O'NEILL, J. and MOLLOY, S. (1997) Optimising Natural Production. Atlantic Salmon Trust / Atlantic Salmon Foundation Conference – Managing Wild Atlantic Salmon : New Challenges, New Techniques – Galway, September, 1997.

O'GRADY, M.F., KELLY, M. and O'REILLY, S. (2008) Brown Trout in Ireland. Irish Freshwater Fisheries Ecology and Management Series : No. 6. Central Fisheries Board, Dublin, Ireland. ISSN: 1649-265X.

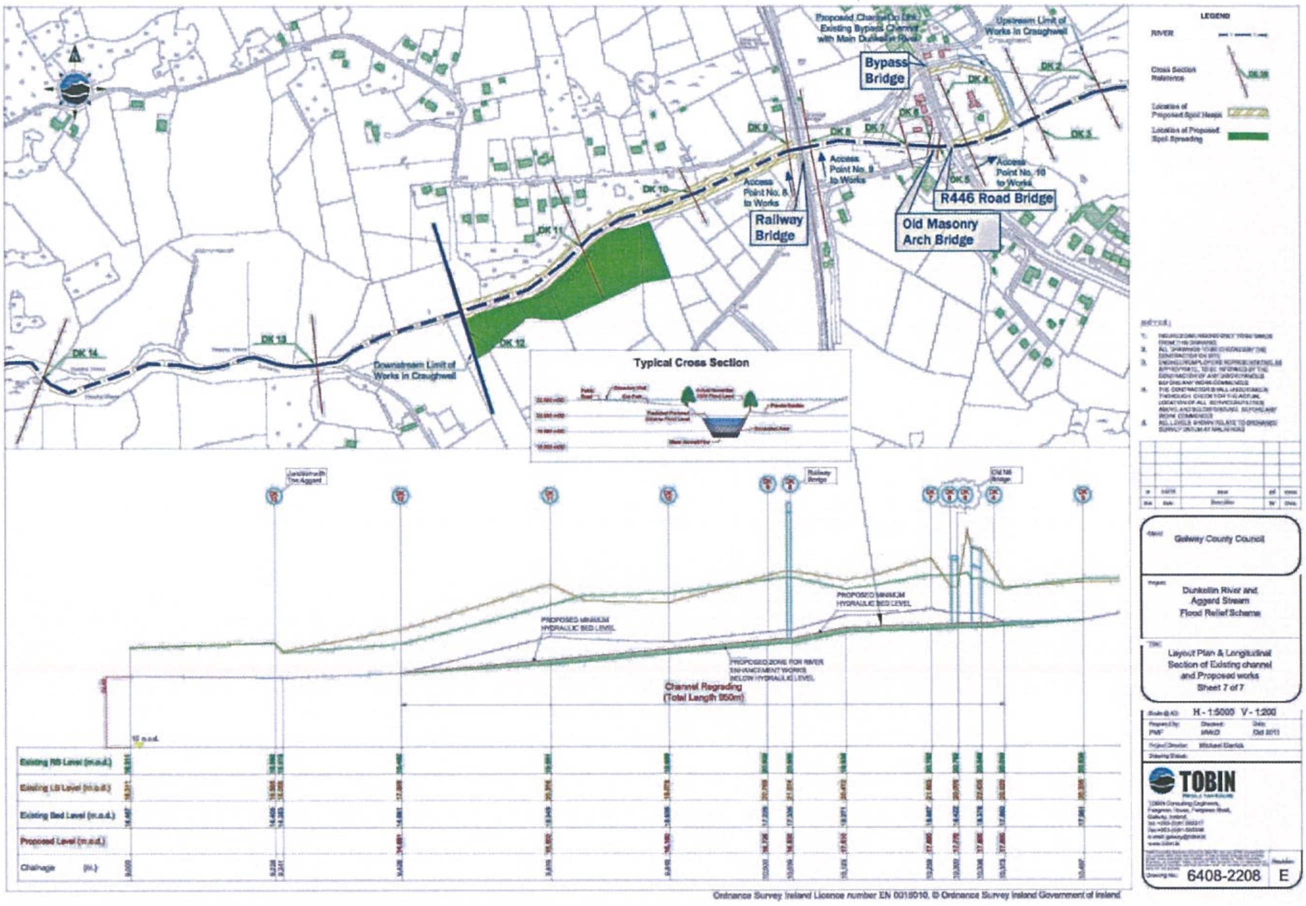
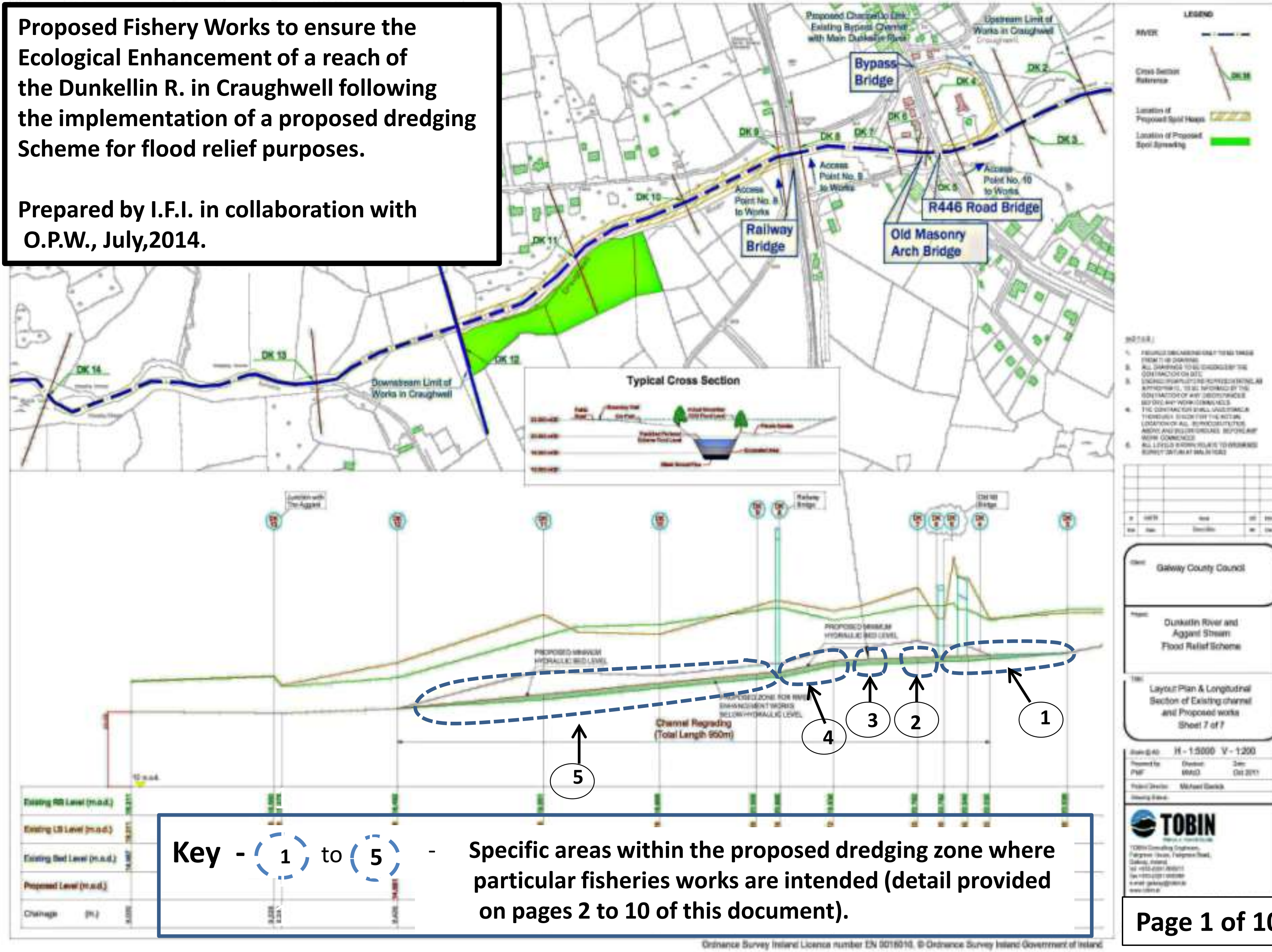


Figure 1. The location, nature and extent of the proposed flood relief scheme on the Craughwell River.

Proposed Fishery Works to ensure the Ecological Enhancement of a reach of the Dunkellin R. in Craughwell following the implementation of a proposed dredging Scheme for flood relief purposes.

Prepared by I.F.I. in collaboration with O.P.W., July,2014.



Key - 1 to 5 - Specific areas within the proposed dredging zone where particular fisheries works are intended (detail provided on pages 2 to 10 of this document).

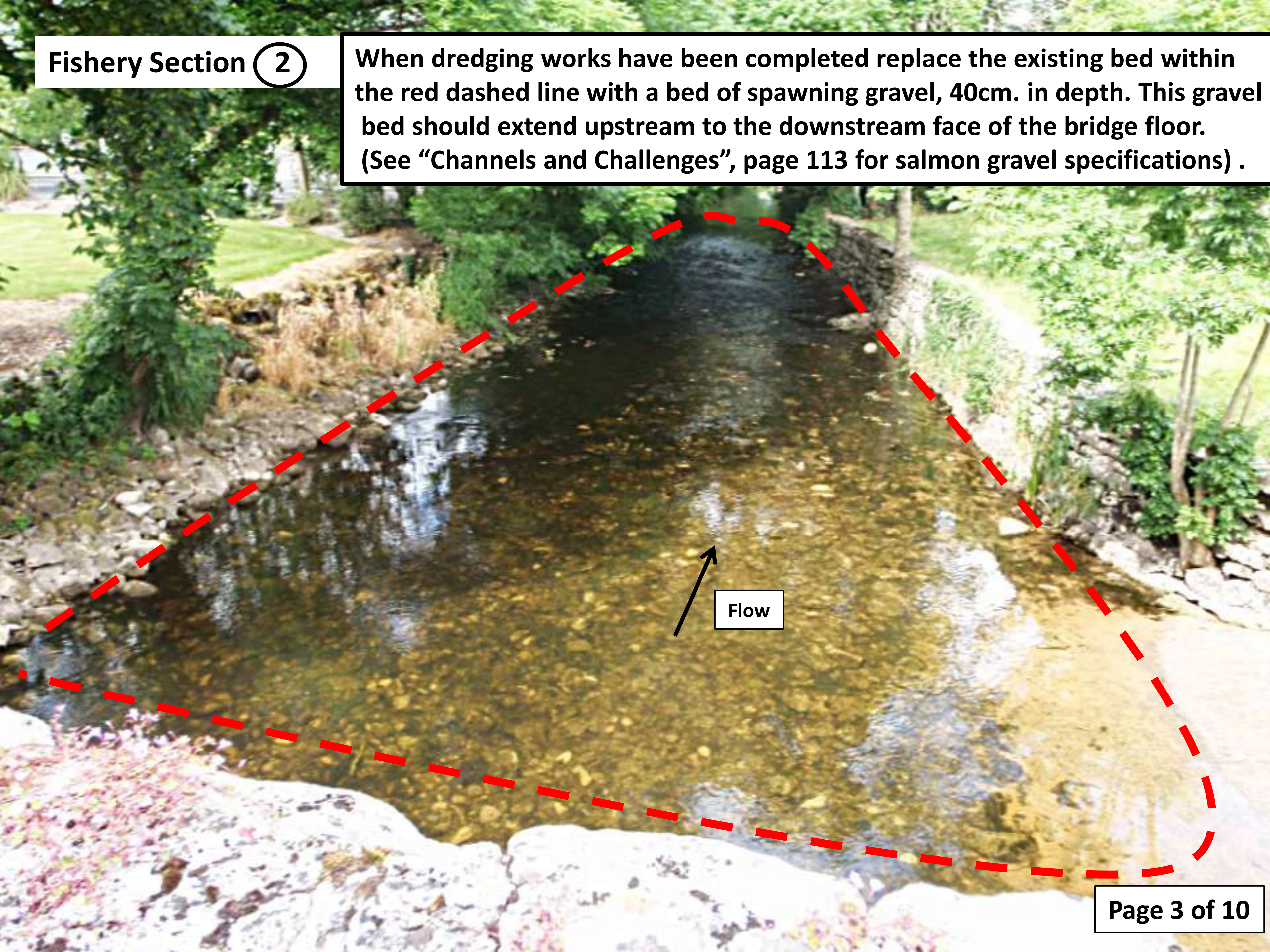
Fishery Section 1

- When dredging is complete in Zone 1. place the existing heavy cobble material currently on the bed back in situ or, replace it with similar material .
- Keep any disturbance to the riparian zone to a minimum.

Looking u/s from the R446 Bridge.

Fishery Section 2

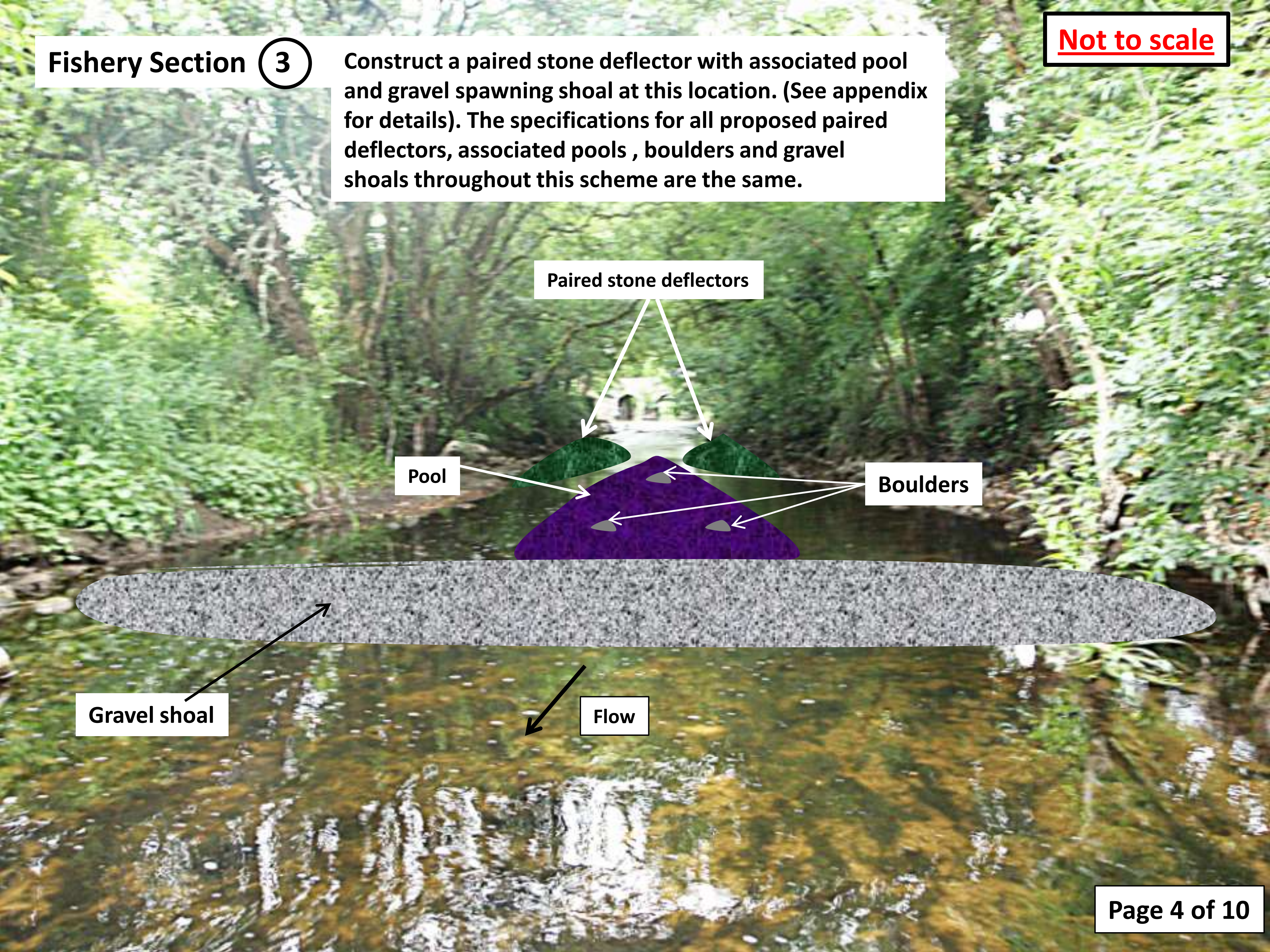
When dredging works have been completed replace the existing bed within the red dashed line with a bed of spawning gravel, 40cm. in depth. This gravel bed should extend upstream to the downstream face of the bridge floor. (See "Channels and Challenges", page 113 for salmon gravel specifications) .



Fishery Section 3

Construct a paired stone deflector with associated pool and gravel spawning shoal at this location. (See appendix for details). The specifications for all proposed paired deflectors, associated pools , boulders and gravel shoals throughout this scheme are the same.

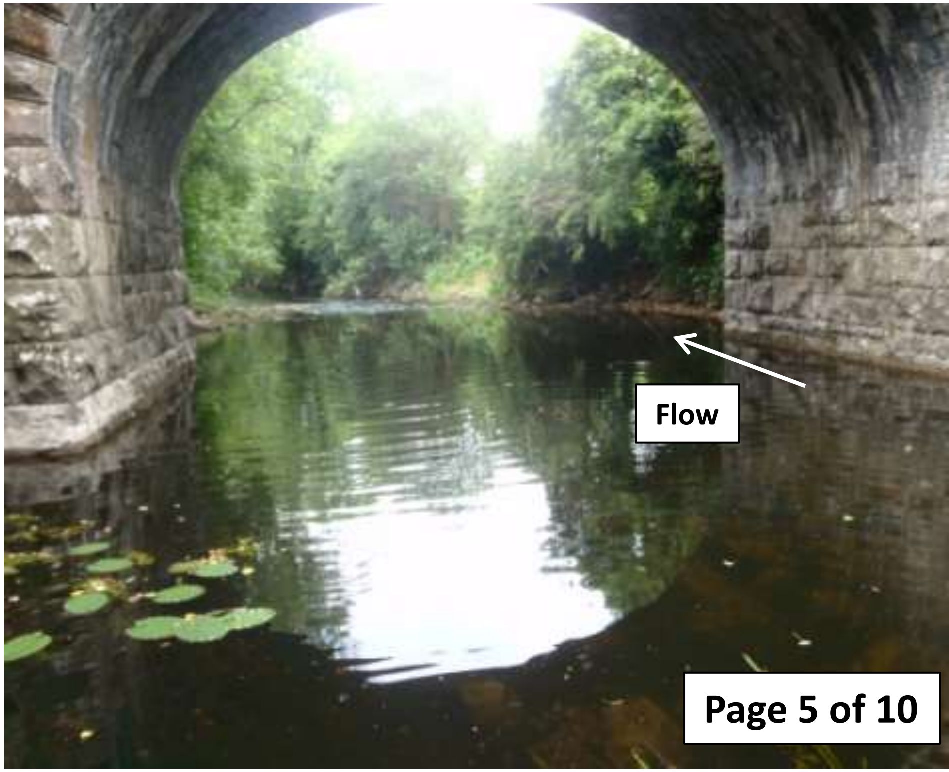
Not to scale



Fishery Section (4)

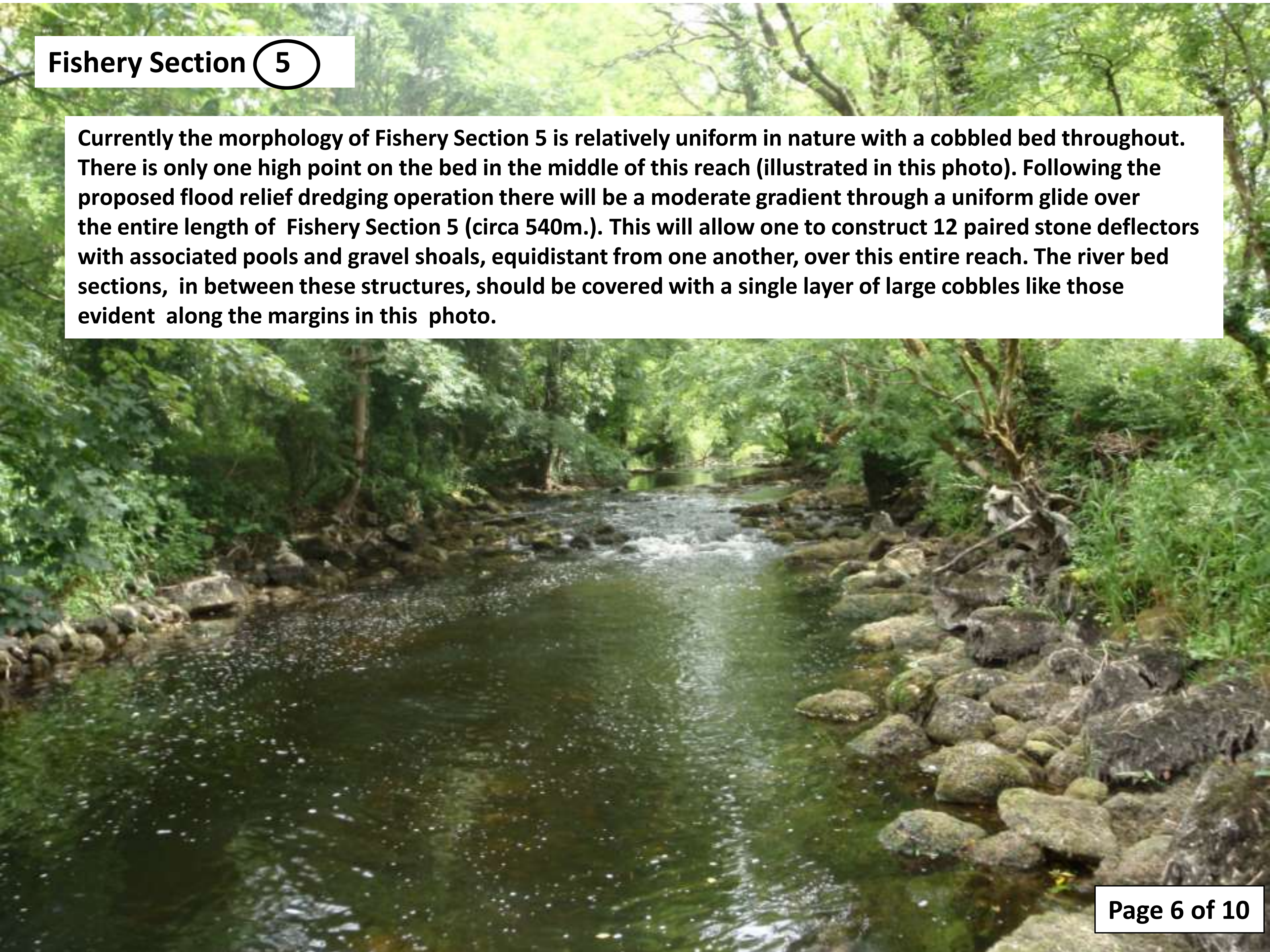
Sequential views looking d/s through Fishery Section 4 from it's upper reaches to the end of this zone at the Railway Bridge.

Following dredging cover the bed of this channel reach with the type of heavy cobble presently in situ and place large boulders (1.5 to 2.0 tonnes) in the channel at 10m. centres.



Fishery Section 5

Currently the morphology of Fishery Section 5 is relatively uniform in nature with a cobbled bed throughout. There is only one high point on the bed in the middle of this reach (illustrated in this photo). Following the proposed flood relief dredging operation there will be a moderate gradient through a uniform glide over the entire length of Fishery Section 5 (circa 540m.). This will allow one to construct 12 paired stone deflectors with associated pools and gravel shoals, equidistant from one another, over this entire reach. The river bed sections, in between these structures, should be covered with a single layer of large cobbles like those evident along the margins in this photo.



Tunnelling Problems

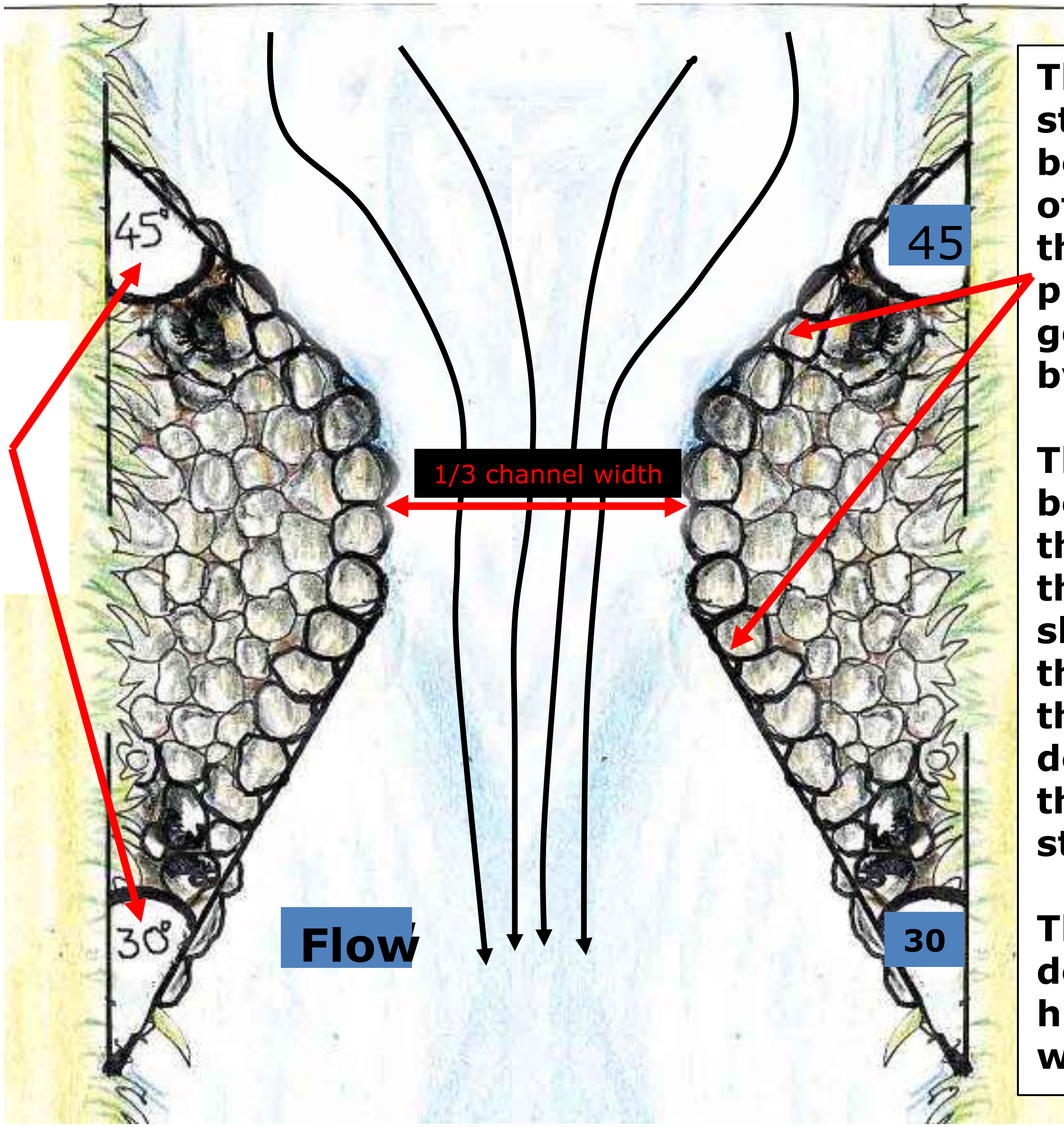
Long sections of this channel reach are heavily tunnelled from the "old masonry bridge" downstream to the end of the proposed dredging reach – note the paucity of ---The overall ecological diversity of flora and fauna in the channel would benefit from a pruning programme carried out along the right bank. Selected areas for pruning should increase the incident light levels on the newly established riffle areas following the proposed physical enhancement of the channel.

Appendix

Key construction features of paired stone deflectors With associated pools and gravel shoals.

A Paired Deflector – Key Features Irrespective of Channel Size

These angles are important to generate the proper flow regime.



The largest heaviest stones available should be used at the outer tip of each deflector where the maximum erosive pressure will be generated by river flows.

These stones will have to be buried a little more than the others because the structure needs to slope out and down from the bank ie. the stones at the outer tip of the deflector need to be at the lowest point of the structure.

The outer tip of each deflector should be no higher than summer water level.

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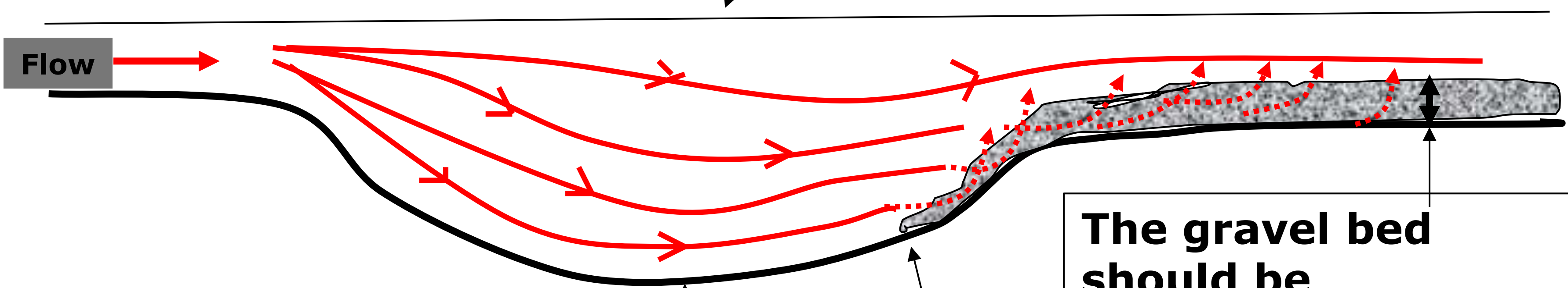
Inland Fisheries Ireland

Key Features of Gravel Placement.

Upwelling of water through the gravels is essential.

Summer Water level



The gravel bed should be 35 to 40 cm. deep. See "Channels and Challenges" for dimensions

River Bed

The pool and gravel bed should be about the same length – about 1.5 times the channel width.

Start to place gravel in the "tail" of the pool.

GALWAY COUNTY COUNCIL

Comhairle Chontae na Gaillimhe

DUNKELLIN RIVER AND AGGARD STREAM FLOOD RELIEF SCHEME

WORKS DESCRIPTION DRAWINGS

SEPTEMBER 2014

TOBIN

Consulting Engineers

DUNKELLIN RIVER AND AGGARD STREAM FLOOD RELIEF SCHEME

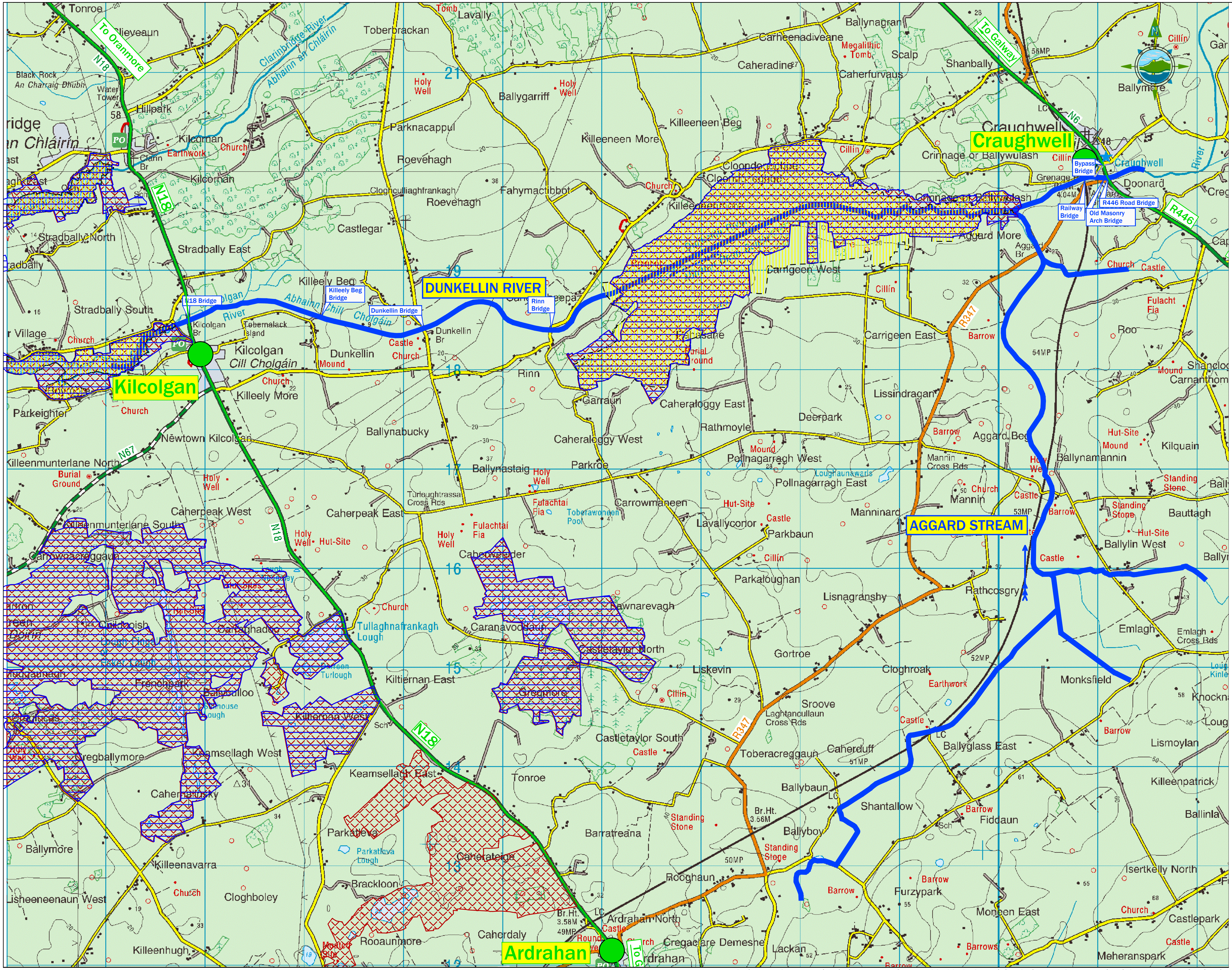
WORKS DESCRIPTION DRAWINGS

TOBIN
Consulting Engineers

ceart agus cóir

SEPTEMBER 2014

DRAWING	Rev	DESCRIPTION
6408-2200	A	Study Area Location
6408-2201	B	November 2009 Flood Event Estimated Flood Extents Based on Aerial Photography after the Event
6408-2202	F	Layout Plan and Longitudinal Section of Existing channel & Proposed Works Sheet 1 of 7
6408-2203	G	Layout Plan and Longitudinal Section of Existing channel & Proposed Works Sheet 2 of 7
6408-2204	G	Layout Plan and Longitudinal Section of Existing channel & Proposed Works Sheet 3 of 7
6408-2205	D	Layout Plan and Longitudinal Section of Existing channel & Proposed Works Sheet 4 of 7
6408-2206	C	Layout Plan and Longitudinal Section of Existing channel & Proposed Works Sheet 5 of 7
6408-2207	C	Layout Plan and Longitudinal Section of Existing channel & Proposed Works Sheet 6 of 7
6408-2208	F	Layout Plan and Longitudinal Section of Existing channel & Proposed Works Sheet 7 of 7
6408-2210	C	Proposed Works at Bridges on the Dunkellin River Sheet 1 of 2
6408-2211	C	Proposed Works at Bridges on the Dunkellin River Sheet 2 of 2
6408-2215	E	Proposed Works at Bridges on the Dunkellin River Sheet
6408-2216	D	Predicted Water Levels for 5%-ile Flows Pre & Post Flood Alleviation Works
6408-2217	D	Predicted Water Levels for 10%-ile Flows Pre & Post Flood Alleviation Works
6408-2218	D	Predicted Water Levels for Mean Annual Flow Conditions Pre & Post Flood Alleviation Works
6408-2220	A	Layout Plan of Proposed Works Along Aggard Stream
6408-2221	C	Locations of Proposed Culvert Replacement along Aggard Stream Sheet 1 of 2
6408-2222	C	Locations of Proposed Culvert Replacement along Aggard Stream Sheet 2 of 2
6408-2250	A	Location of Site Notices



LEGEND

RIVER

SPECIAL PROTECTION AREAS (SPA's)

PROPOSED NATURAL HERITAGE AREAS (pNHA's)

NATURAL HERITAGE AREAS (NHA's)

SPECIAL AREAS OF CONSERVATION (SAC's)

NOTES:

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5. ALL LEVELS SHOWN RELATE TO ORDNANCE SURVEY DATUM AT MALIN HEAD

Rev	Date	Description	By	Chkd.
A	Oct'11	First Issue	PMF	MMcD

Client: Galway County Council

Project: Dunkellin River and Aggard Stream Flood Relief Scheme

Title: Study Area Location

Scale @ A1: 1:17,500
Scale @ A3: 1:35,000

Prepared by:	Checked:	Date:
PMF	MMcD	Oct 2011

Project Director: Michael Garrick

Drawing Status:

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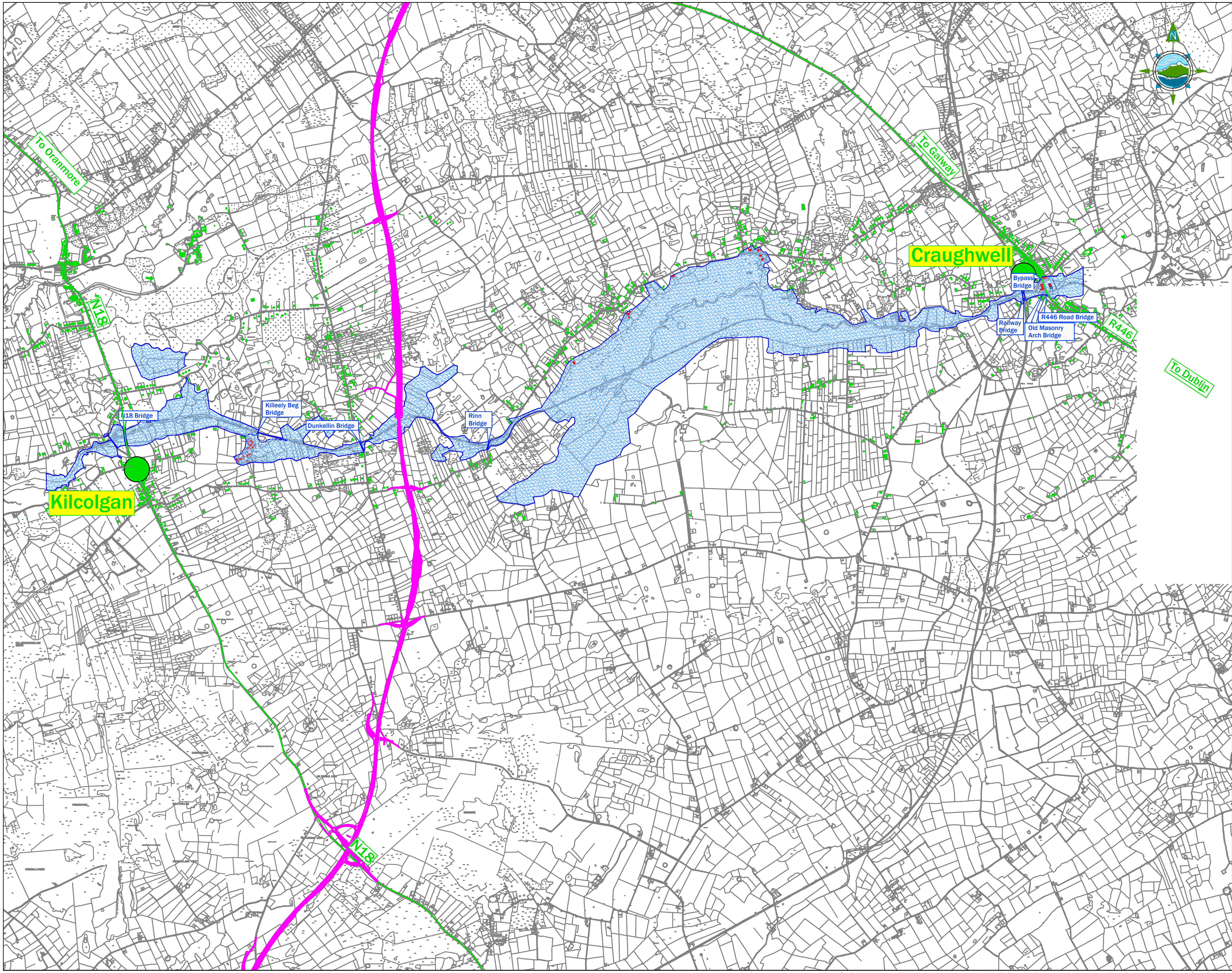
www.tobin.ie

Drawing No.: 6408-2200

Revision: A



LEGEND

Estimated flood extent based on aerial photography after the November 2009 event

Proposed M18 Motorway

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Rev	Date	Description	By	Chkd.
B	July/14	Issue	CK	MMcD

Client: Galway County Council

Project: Dunkellin River and Aggard Stream Flood Relief Scheme

Title: November 2009 Flood Event Estimated Flood Extents Based on Aerial Photography after the Event

Scale @ A1: 1:17,500
Scale @ A3: 1:35,000

Prepared by: PFM
Checked: MMcD
Date: Oct 2011

Project Director: Michael Garrick

Drawing Status:

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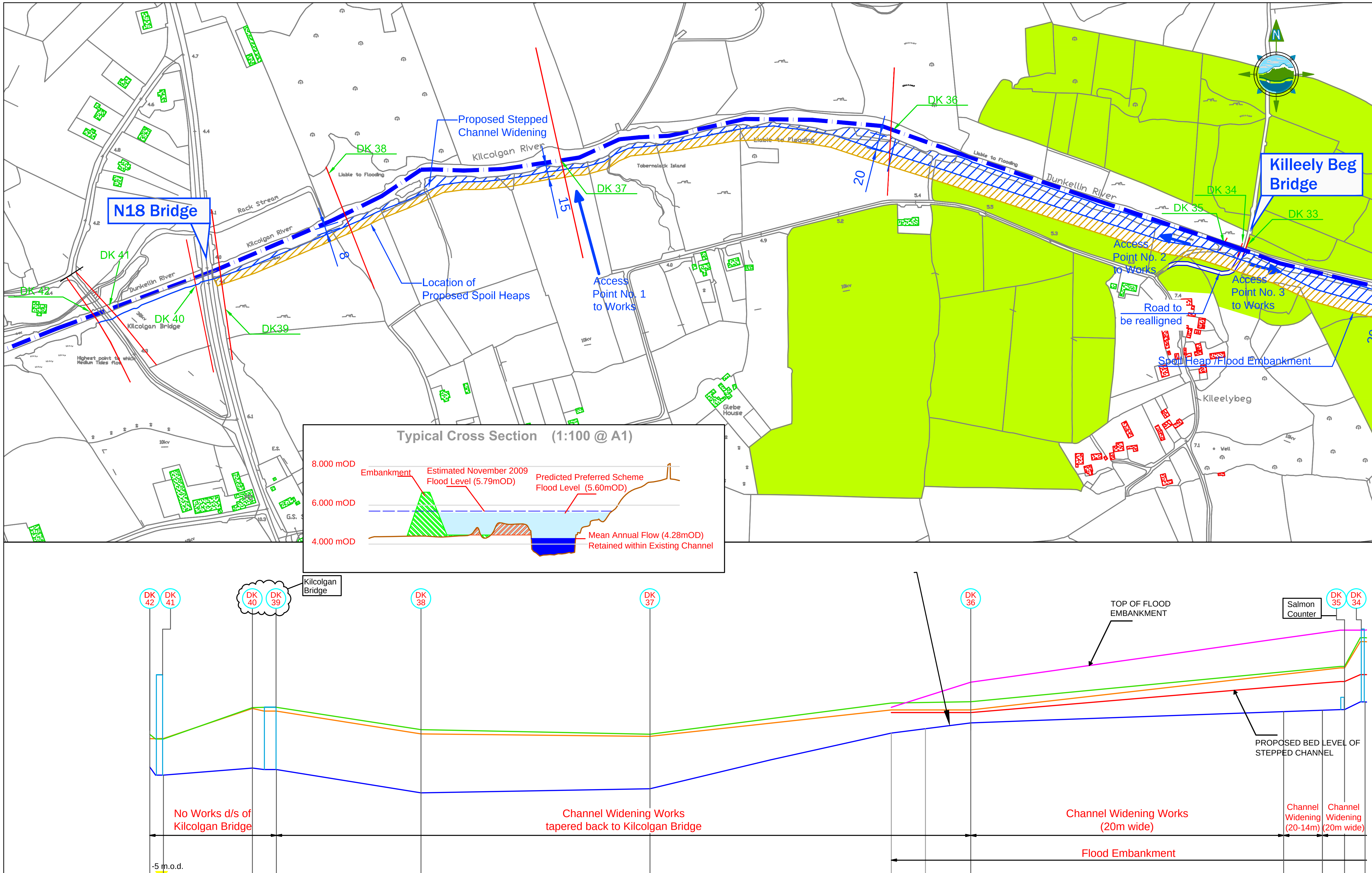
Drawing No.: 6408-2201

Revision: B



	DK 42	DK 41	DK 40	DK 39	DK 38	DK 37			DK 36			DK 35	DK 34
Existing RB Level (m.o.d.)	2.369	2.130	3.749	3.769	2.614	2.376	3.988	4.018	4.059	5.574	5.780	5.872	7.353
Existing LB Level (m.o.d.)	2.154	2.162	3.707	3.576	2.393	2.270	3.635	3.635	3.635	5.466	5.691	7.151	7.151
Existing Bed Level (m.o.d.)	0.683	0.269	0.636	0.559	-0.642	-0.427	2.437	2.664	2.967	3.547	3.619	3.652	4.043
Proposed Stepped Channel Level (m.o.d.)							3.500	3.500	3.500	4.855	5.023	5.100	5.450
Top of Proposed Embankment (m.o.d.)							3.769	4.323	5.060	7.338	7.614	7.750	7.750
Chainage (m.)	0	17	132	163	350	645	956	1.000	1.058	1.462	1.512	1.540	1.567

LEGEND

- RIVER
- Cross Section Reference (DK 38)
- Proposed Stepped Channel Widening
- Location of Proposed Spoil Heaps / Flood Embankments
- Location of Proposed Spoil Spreading

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Rev	Date	Description	By	Chkd.
F	Sept/14	Issue	CK	MMcD

Client: Galway County Council

Project: Dunkellin River and and Aggard Stream Flood Relief Scheme

Title: Layout Plan & Longitudinal Section of Existing channel and Proposed works Sheet 1 of 7

Scale @ A1: H - 1:2500 V - 1:100
Scale @ A3: H - 1:5000 V - 1:200

Prepared by:	Checked:	Date:
PFM	MMcD	Oct 2011

Project Director: Michael Garrick

Drawing Status:

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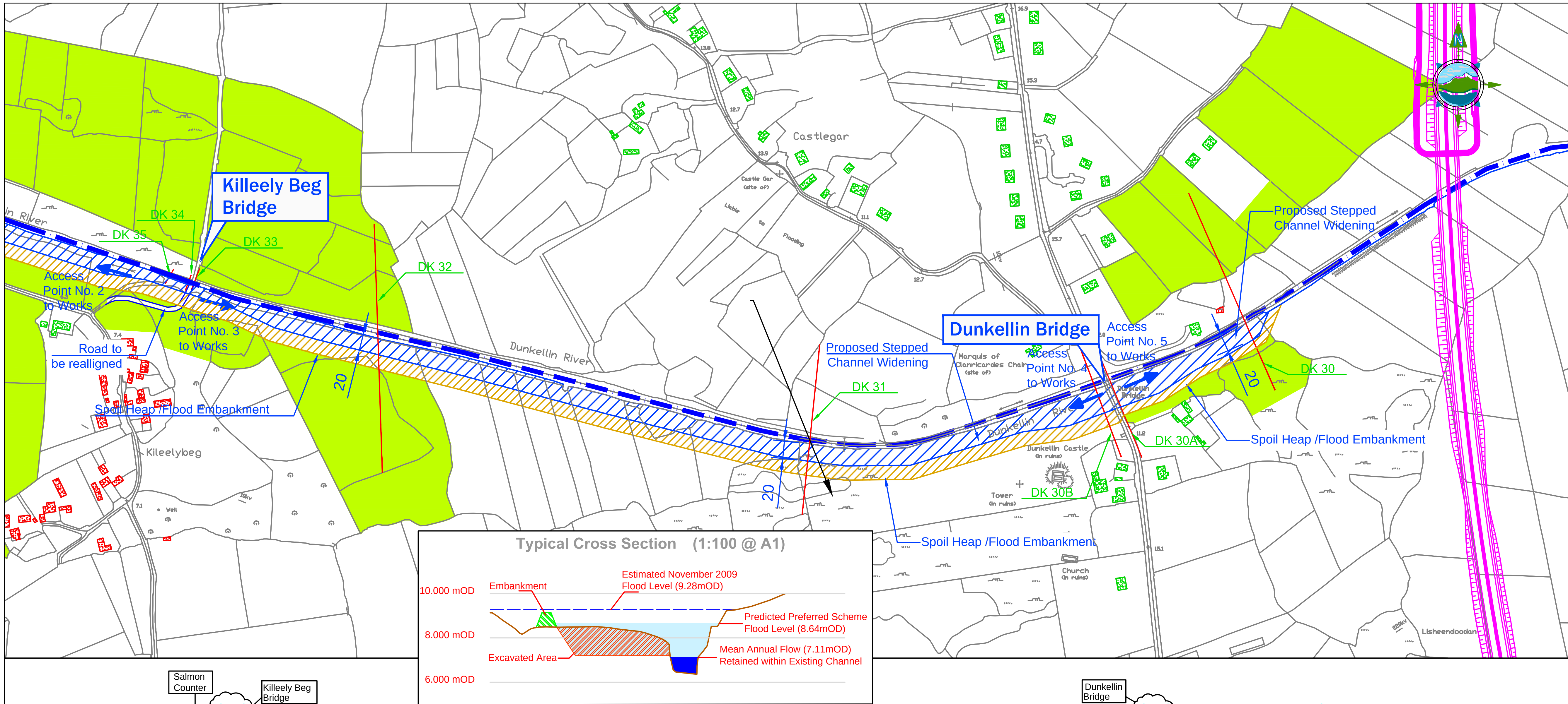
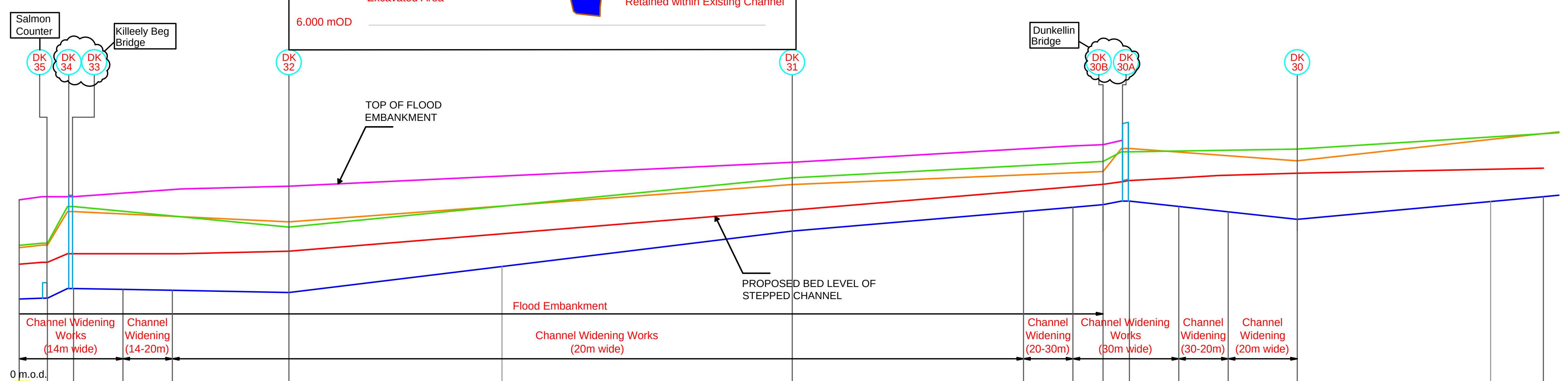
Drawing No.: 6408-2202 Revision: F





Existing RB Level (m.o.d.)	5.780	5.872	7.353	7.162	6.971	6.521	7.364	8.513	9.002	9.107	9.170	9.563	9.595	9.627	9.671	10.063	10.298
Existing LB Level (m.o.d.)	5.691	7.151	7.151	7.056	6.960	6.735	7.364	8.237	8.631	8.716	8.766	9.699	9.552	9.405	9.200	10.063	10.298
Existing Bed Level (m.o.d.)	3.619	3.652	4.043	4.006	3.970	3.883	4.931	6.359	7.154	7.323	7.426	7.572	7.355	7.137	6.833	7.552	7.748
Proposed Stepped Channel Level (m.o.d.)	5.023	5.100	5.450	5.450	5.450	5.550	6.252	7.210	7.983	8.148	8.250	8.400	8.508	8.613	8.700	8.857	8.900
Top of Proposed Embankment (m.o.d.)	7.614	7.750	7.750	7.892	8.035	8.170	8.580	9.140	9.686	9.802	9.850	10.014					
Chainage (m.)	1,512	1,540	1,567	1,567	1,667	1,785	2,000	2,294	2,528	2,578	2,608	2,635	2,685	2,735	2,804	3,000	3,053

LEGEND

- RIVER
- Cross Section Reference (DK 38)
- Proposed Stepped Channel Widening
- Location of Proposed Spoil Heaps / Flood Embankments
- Location of Proposed Spoil Spreading
- Proposed M18 Motorway

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Rev	Date	Description	By	Chkd.
G	Sept/14	Issue	CK	MMcD

Client: Galway County Council

Project: Dunkellin River and Aggard Stream Flood Relief Scheme

Title: Layout Plan & Longitudinal Section of Existing channel and Proposed works Sheet 2 of 7

Scale @ A1: H - 1:2500 V - 1:100
Scale @ A3: H - 1:5000 V - 1:200

Prepared by: PFM | Checked: MMcD | Date: Oct 2011

Project Director: Michael Garrick

Drawing Status:

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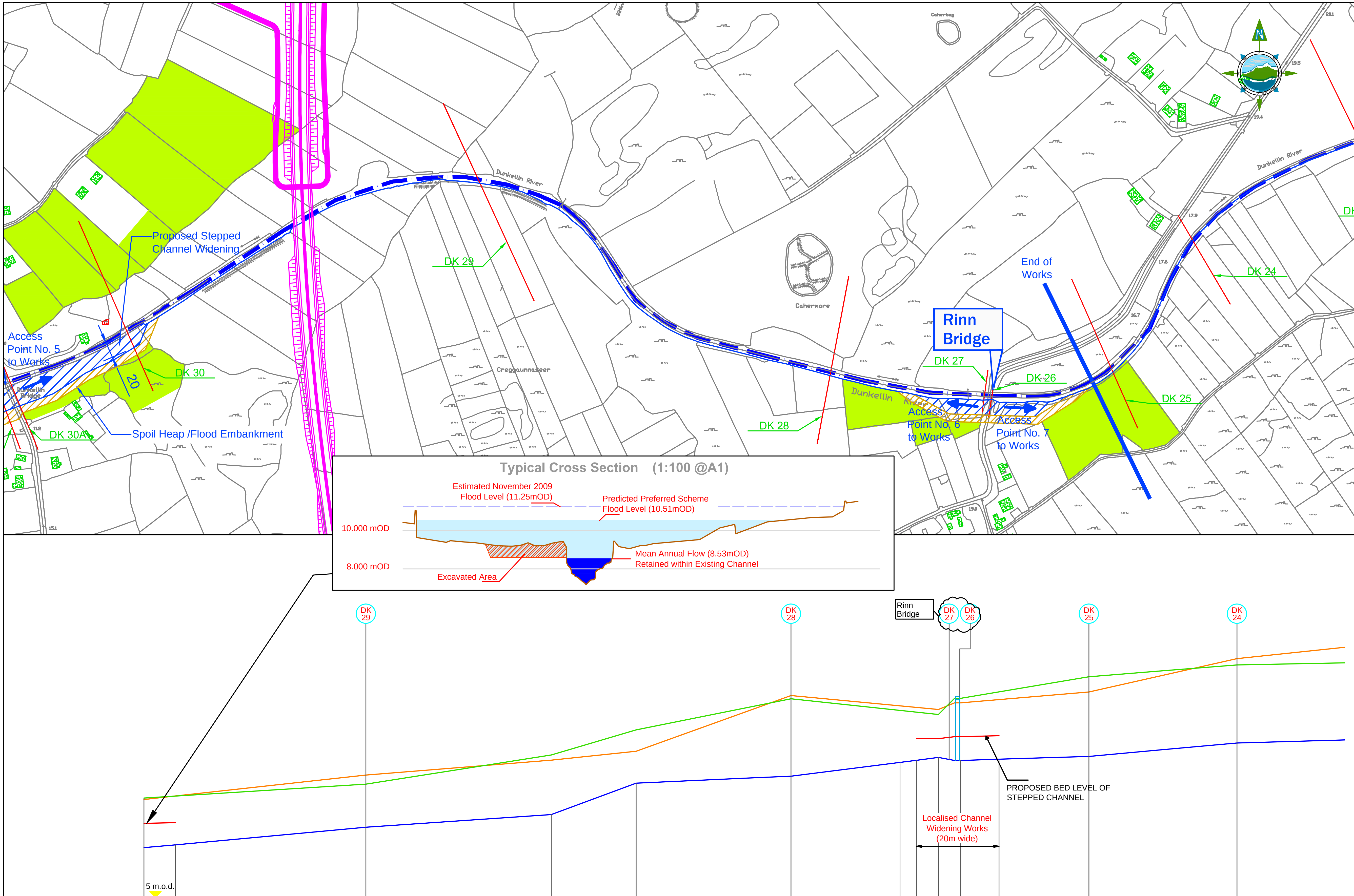
Drawing No.: 6408-2203 | Revision: G



Existing RB Level (m.o.d.)	10.298	10.919	12.443	13.751	15.382	15.012	14.680	14.556	15.406	15.741	16.527	17.152
Existing LB Level (m.o.d.)	10.298	11.395	12.172	12.634	15.548	15.012	14.931	14.822	15.167	15.337	15.736	17.477
Existing Bed Level (m.o.d.)	7.748	8.664	9.323	10.969	11.333	12.052	12.160	12.312	12.155	12.220	12.370	13.070
Proposed Stepped Channel Level (m.o.d.)	8.900						13.300	13.300	13.400	13.450		
Chainage (m.)	3,053	3,302	3,544	3,655	3,858	4,000	4,021	4,050	4,079	4,129	4,247	4,440

LEGEND

RIVER

Cross Section Reference — DK 38

Proposed Stepped Channel Widening

Location of Proposed Spoil Heaps

Location of Proposed Spoil Spreading

Proposed M18 Motorway

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Rev	Date	Description	By	Chkd.
G	Sept/14	Issue	CK	MMcD

Client: Galway County Council

Project: Dunkellin River and Aggard Stream Flood Relief Scheme

Title: Layout Plan & Longitudinal Section of Existing channel and Proposed works Sheet 3 of 7

Scale @ A1: H - 1:2500 V - 1:100
Scale @ A3: H - 1:5000 V - 1:200

Prepared by: PMF | Checked: MMcD | Date: Oct 2011

Project Director: Michael Garrick

Drawing Status:

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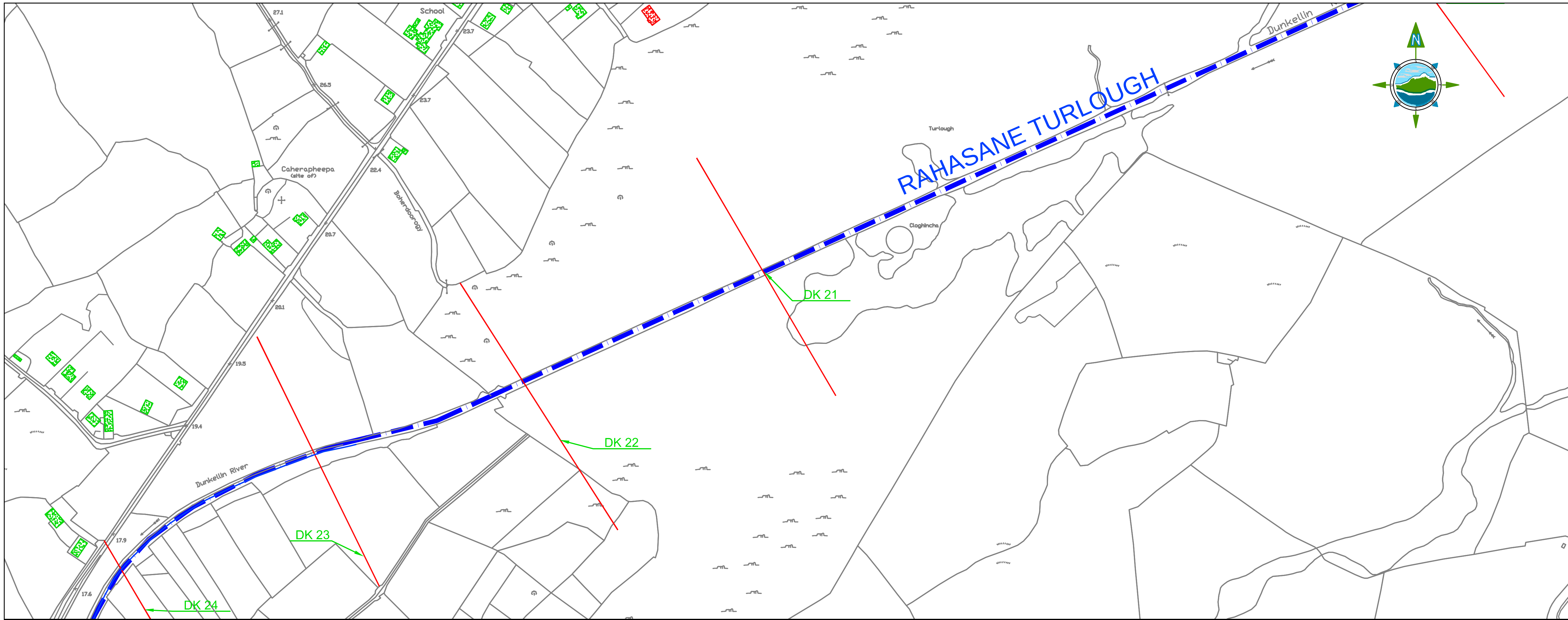
Drawing No.: 6408-2204 Revision: G



LEGEND

- RIVER
- Cross Section Reference (DK 38)
- Proposed Stepped Channel Widening
- Location of Proposed Spoil Heaps
- Location of Proposed Spoil Spreading

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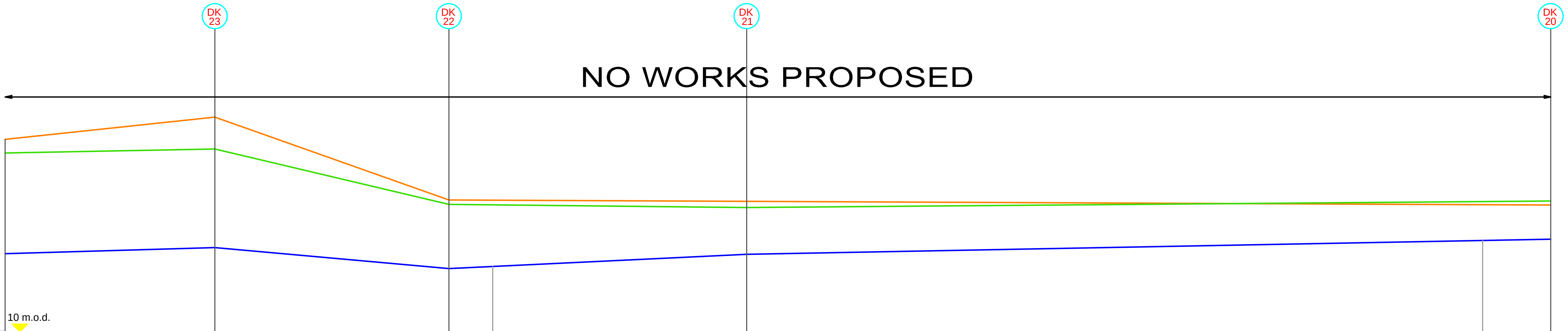
Rev	Date	Description	By	Chkd.
D	Sept/13	Issue	CK	MMcD

NO WORKS PROPOSED



Existing RB Level (m.o.d.)	17.205	17.249	15.136	15.307	15.008	15.125	15.271
Existing LB Level (m.o.d.)	17.760	18.652	15.315	15.307	15.260	15.125	15.112
Existing Bed Level (m.o.d.)	13.146	13.387	12.545	12.629	13.120	13.677	13.729
Chainage (m.)	4.507	4.719	4.956	5.000	5.257	6.000	6.069

Client: Galway County Council

Project: Dunkellin River and Aggard Stream Flood Relief Scheme

Title: Layout Plan & Longitudinal Section of Existing channel and Proposed works Sheet 4 of 7

Scale @ A1: H - 1:2500 V - 1:100
Scale @ A3: H - 1:5000 V - 1:200

Prepared by: PMF | Checked: MMcD | Date: Oct 2011

Project Director: Michael Garrick

Drawing Status:

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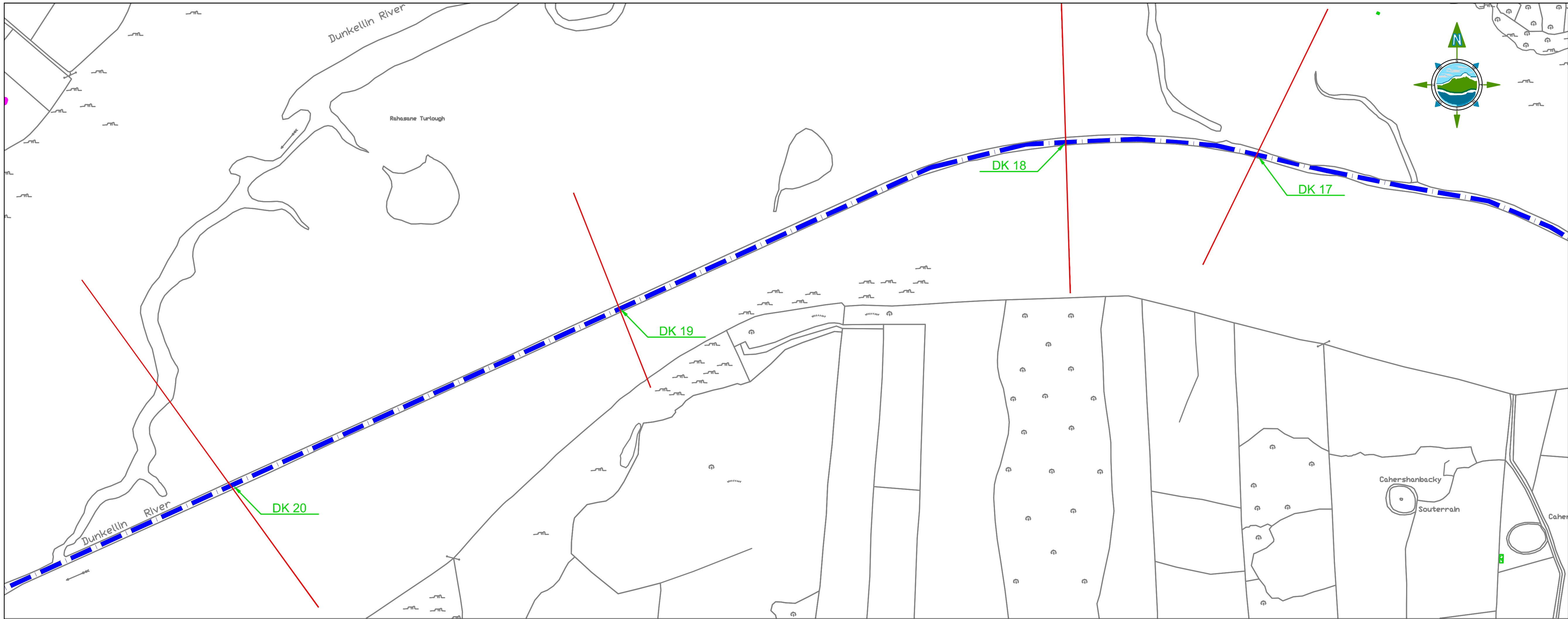
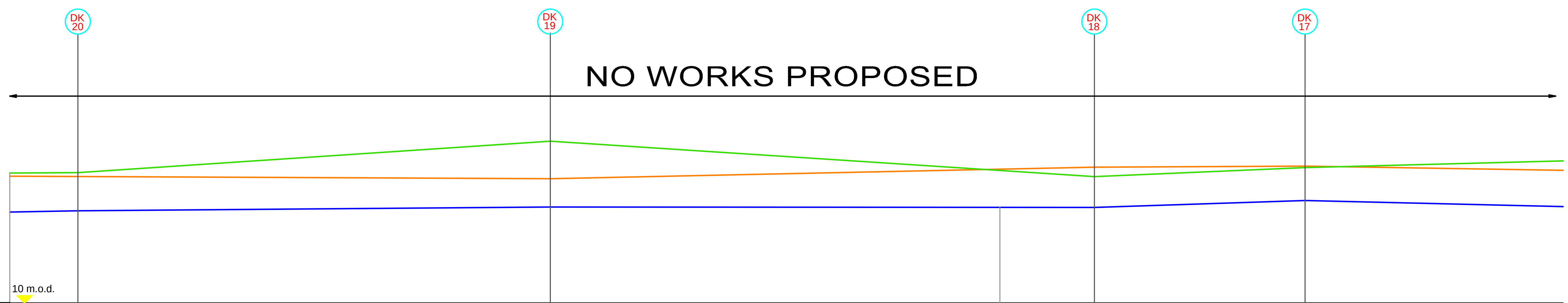
Drawing No.: 6408-2205 | Revision: D





Existing RB Level (m.o.d.)	15.125	15.271	16.534	15.410	15.103	15.474
Existing LB Level (m.o.d.)	15.125	15.112	17.249	15.410	15.491	15.526
Existing Bed Level (m.o.d.)	13.677	13.729	13.878	13.865	13.862	14.146
Chainage (m.)	6.000	6.069	6.546	7.000	7.095	7.308

LEGEND

RIVER

Cross Section Reference — DK 38

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Rev	Date	Description	By	Chkd.
C	Sept/13	Issue	CK	MMcD

Client: Galway County Council

Project: Dunkellin River and Aggard Stream Flood Relief Scheme

Title: Layout Plan & Longitudinal Section of Existing channel and Proposed works Sheet 5 of 7

Scale @ A1: H - 1:2500 V - 1:100
Scale @ A3: H - 1:5000 V - 1:200

Prepared by: PMF | Checked: MMcD | Date: Oct 2011

Project Director: Michael Garrick

Drawing Status:

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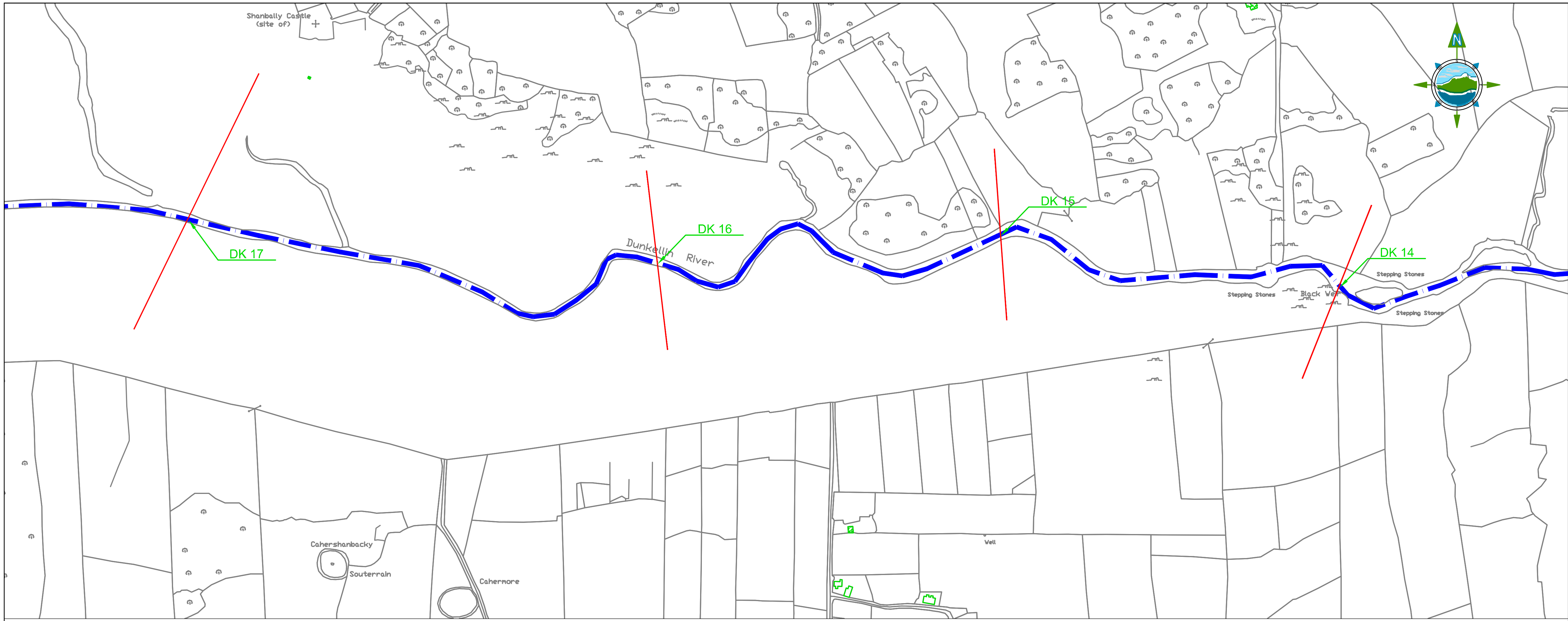
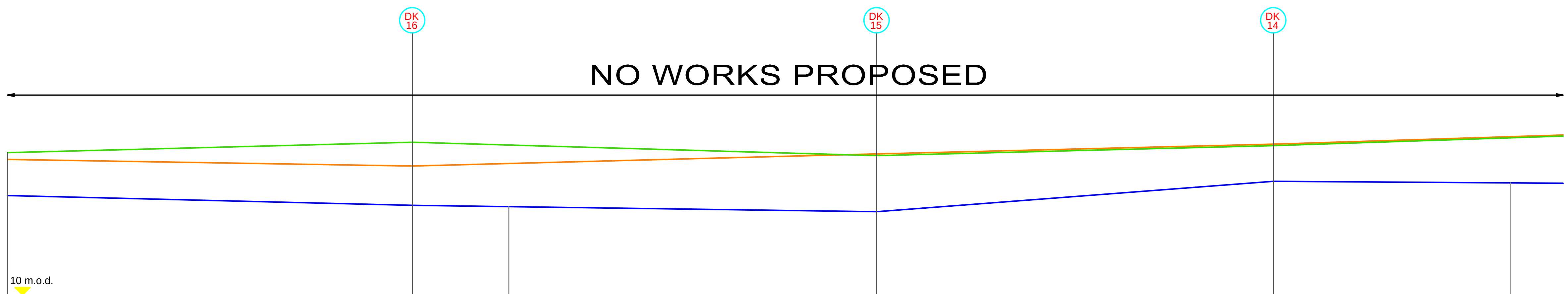
Drawing No.: 6408-2206 Revision: C





Existing RB Level (m.o.d.)	15.670	16.085	15.243	15.552	15.956	16.311
Existing LB Level (m.o.d.)	15.401	15.142	15.243	15.626	16.013	16.311
Existing Bed Level (m.o.d.)	13.961	13.577	13.523	13.317	14.532	14.467
Chainage (m.)	7.501	7.904	8.000	8.367	8.763	9.000

LEGEND

RIVER

Cross Section Reference — DK 38

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5. ALL LEVELS SHOWN RELATE TO ORDNANCE SURVEY DATUM AT MALIN HEAD

Rev	Date	Description	By	Chkd.
C	Sept/13	Issue	CK	MMcD

Client: Galway County Council

Project: Dunkellin River and Aggard Stream Flood Relief Scheme

Title: Layout Plan & Longitudinal Section of Existing channel and Proposed works Sheet 6 of 7

Scale @ A1: H - 1:2500 V - 1:100
Scale @ A3: H - 1:5000 V - 1:200

Prepared by: PMF | Checked: MMcD | Date: Oct 2011

Project Director: Michael Garrick

Drawing Status:

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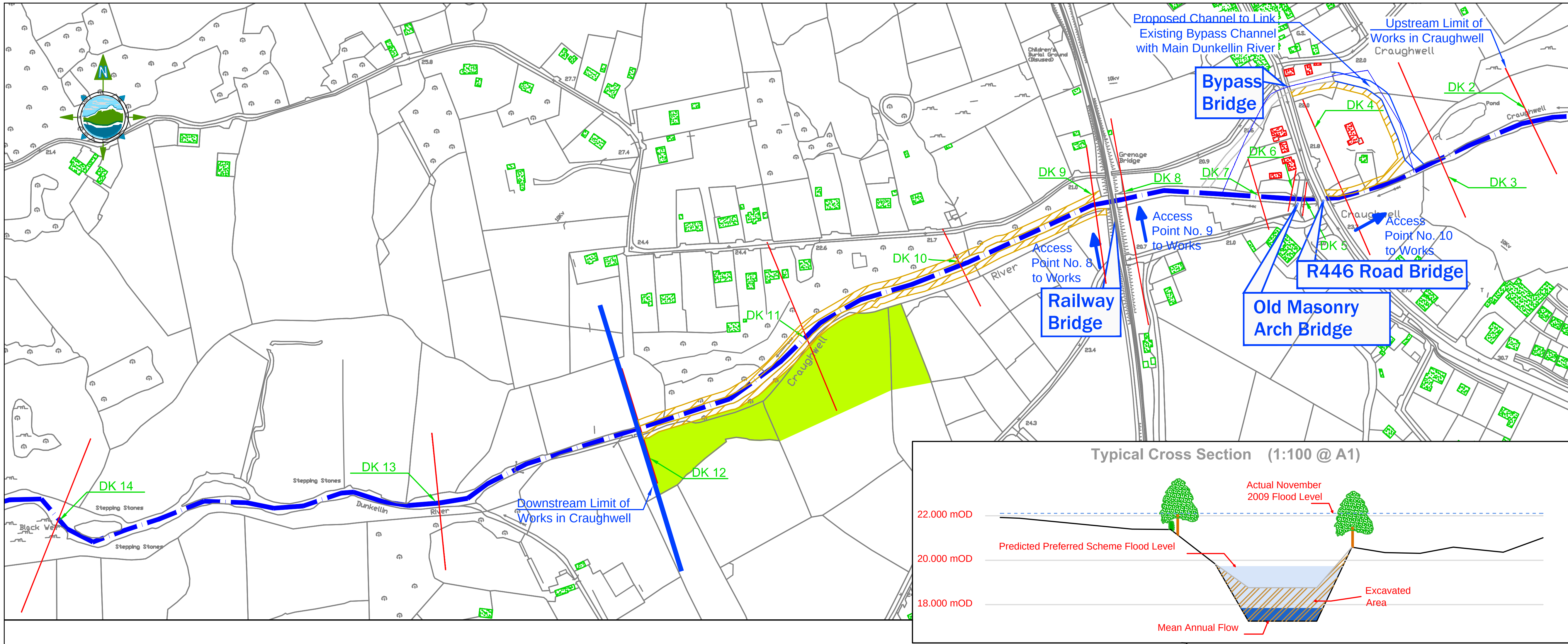
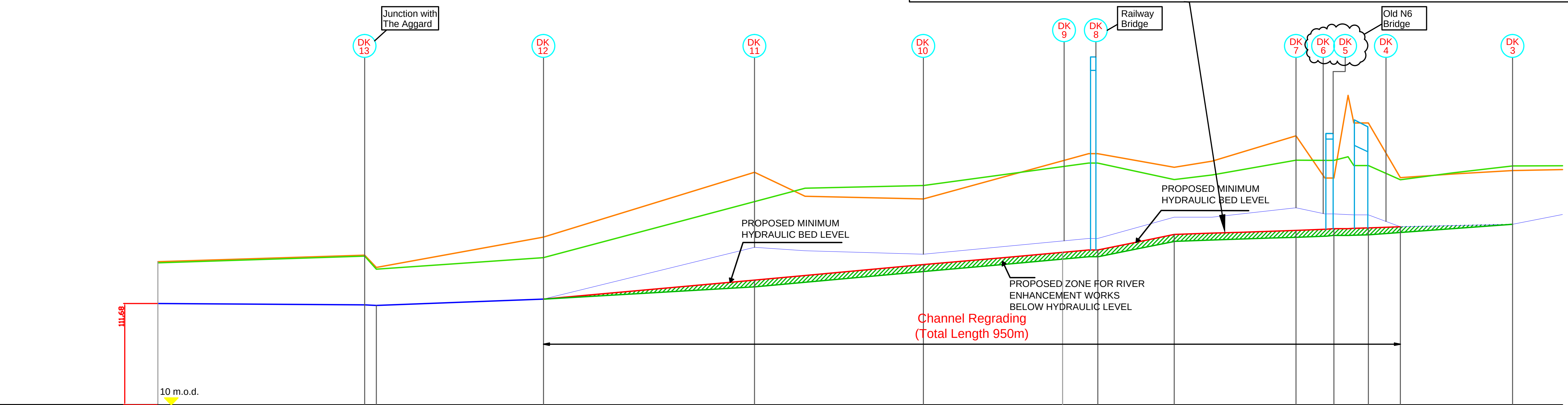
Drawing No.: 6408-2207 | Revision: C





Existing RB Level (m.o.d.)	16.311	16.560	15.978	16.492	19.551	19.669	20.509	20.666	19.936	20.792	20.782	20.549	20.030	20.538
Existing LB Level (m.o.d.)	16.311	16.598	16.056	17.398	20.256	19.078	20.759	21.074	20.472	21.863	20.005	22.435	20.020	20.335
Existing Bed Level (m.o.d.)	14.467	14.405	14.383	14.661	16.949	16.638	17.225	17.335	18.271	18.687	18.422	18.378	17.850	17.961
Proposed Level (m.o.d.)				14.661	15.500	16.180	16.726	16.830	17.510	17.690	17.770	17.800	17.850	
Chainage (m.)	9,000	9,228	9,241	9,426	9,659	9,846	10,000	10,039	10,123	10,258	10,300	10,338	10,373	10,497

LEGEND

RIVER

Cross Section Reference (DK 38)

Location of Proposed Spoil Heaps

Location of Proposed Spoil Spreading

NOTES:

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5. ALL LEVELS SHOWN RELATE TO ORDNANCE SURVEY DATUM AT MALIN HEAD

Rev	Date	Description	By	Chkd.
F	Sept/14	Issue	DC	MMcD

Client: Galway County Council

Project: Dunkellin River and Aggard Stream Flood Relief Scheme

Title: Layout Plan & Longitudinal Section of Existing channel and Proposed works Sheet 7 of 7

Scale @ A1: H - 1:2500 V - 1:100
Scale @ A3: H - 1:5000 V - 1:200

Prepared by: PMF | Checked: MMcD | Date: Oct 2011

Project Director: Michael Garrick

Drawing Status:

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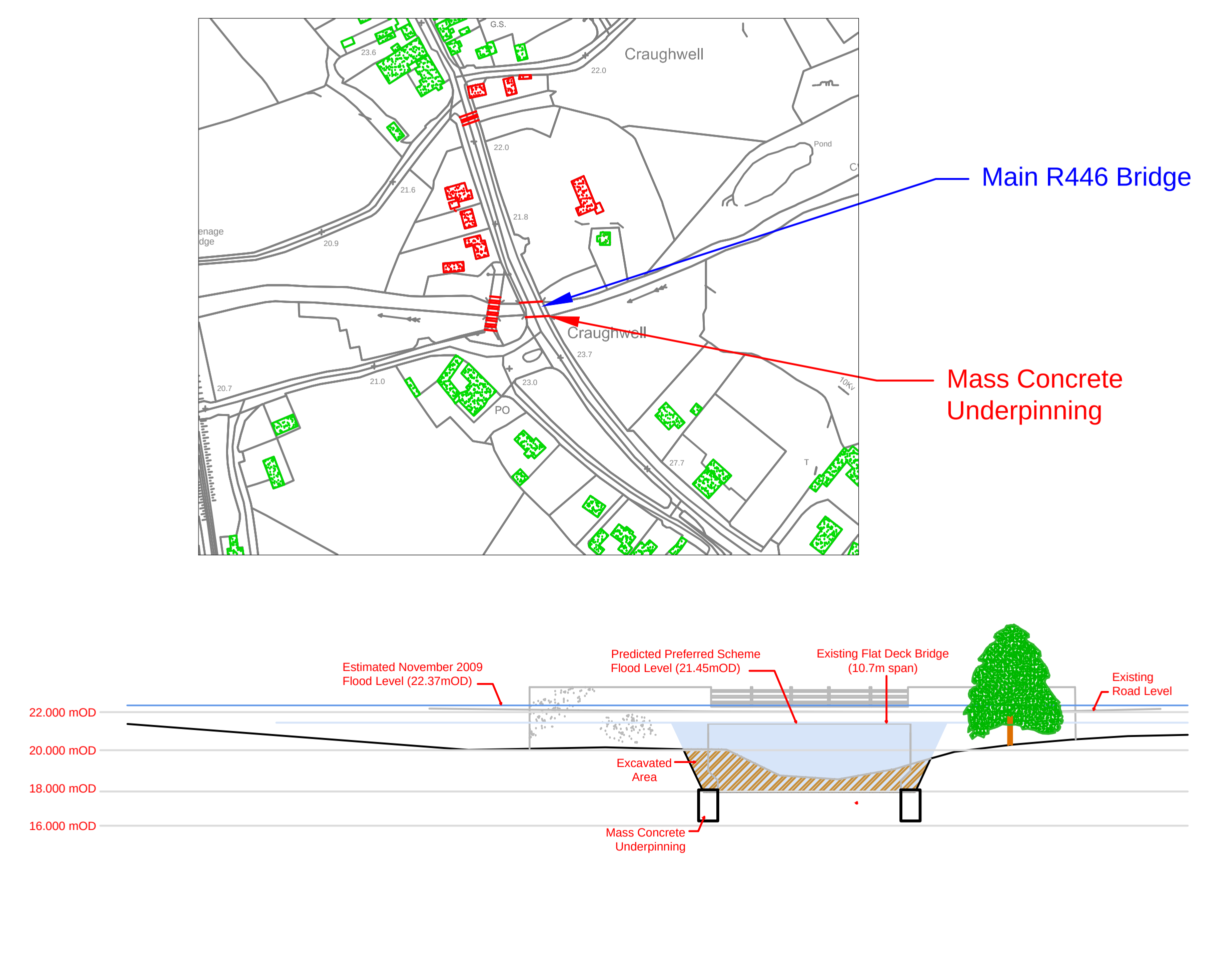
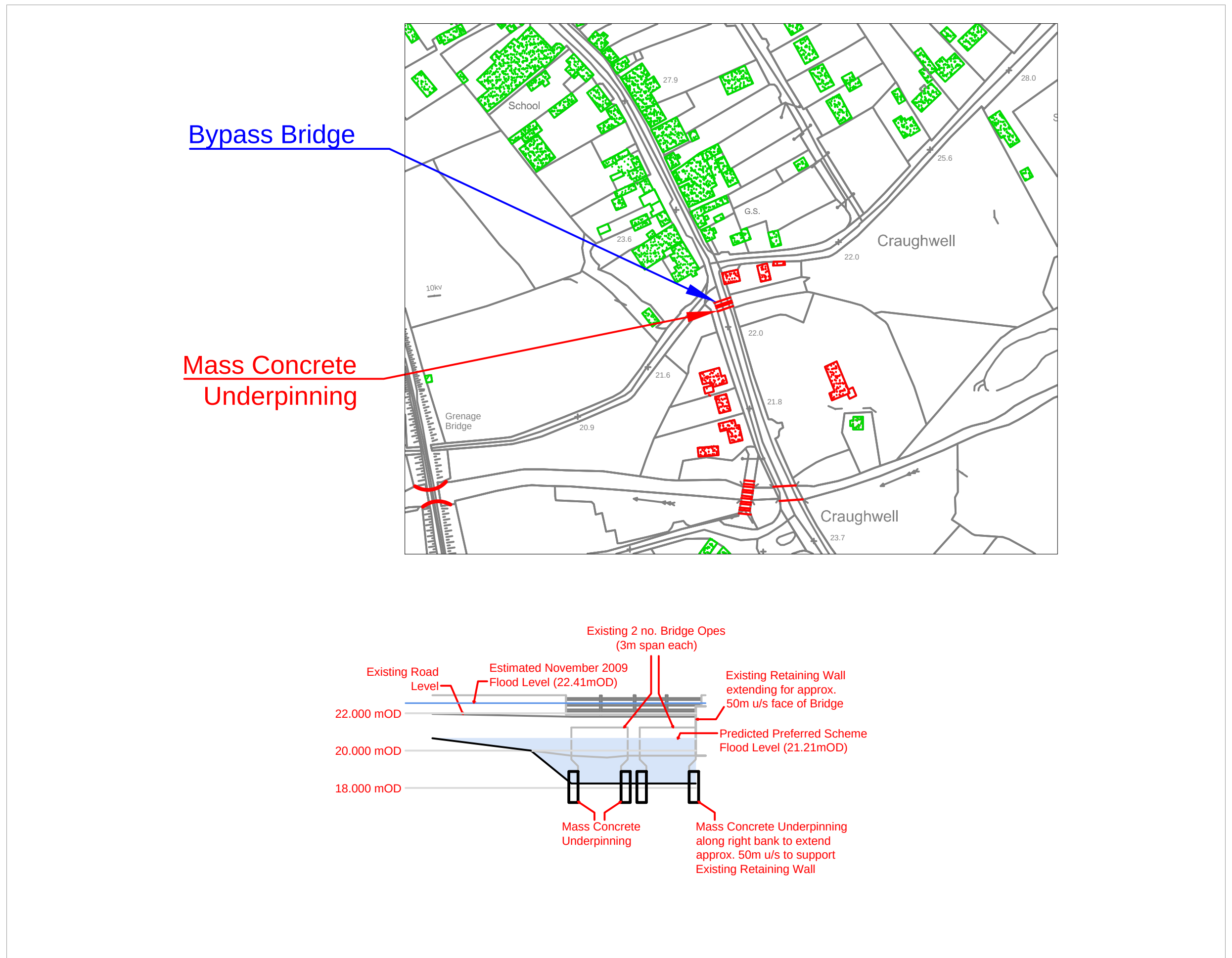
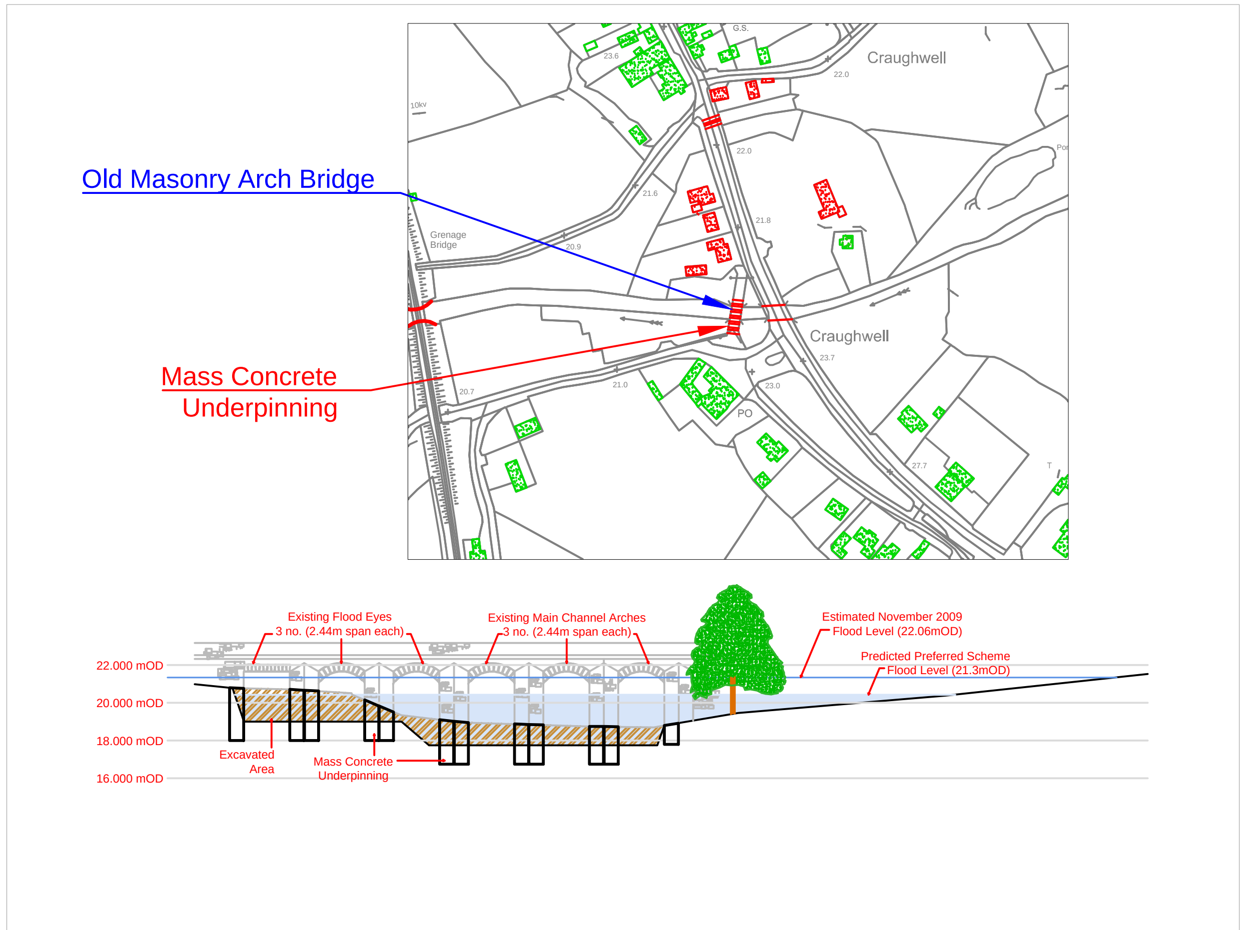
Drawing No.: 6408-2208 | Revision: F



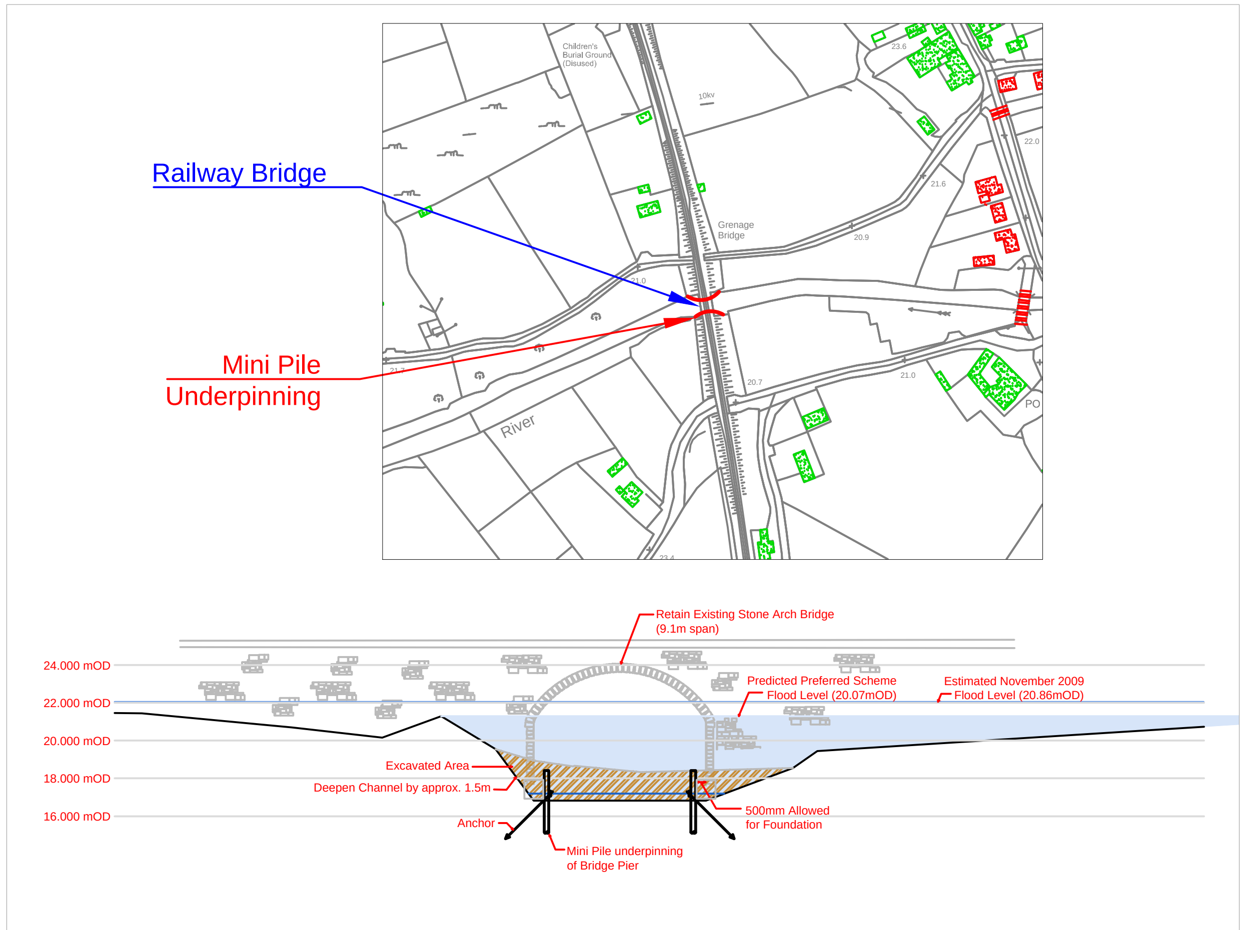
Main R446 Bridge



Bypass Channel Bridge



Old Masonry Arch Pedestrian Bridge



Railway Bridge

NOTES:

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Rev	Date	Description	By	Chkd.
C	Sept/14	Issue	CK	MMcD

Client: Galway County Council

Project: Dunkellin River and Aggard Stream Flood Relief Scheme

Title: Proposed Works at Bridges on the Dunkellin River Sheet 1 of 2

Scale @ A1:	Elevation 1:200	Plan 1:2500
Scale @ A3:	Elevation 1:400	Plan 1:5000
Prepared by: PMF	Checked: MMcD	Date: Oct 2011

Project Director: Michael Garrick

Drawing Status:

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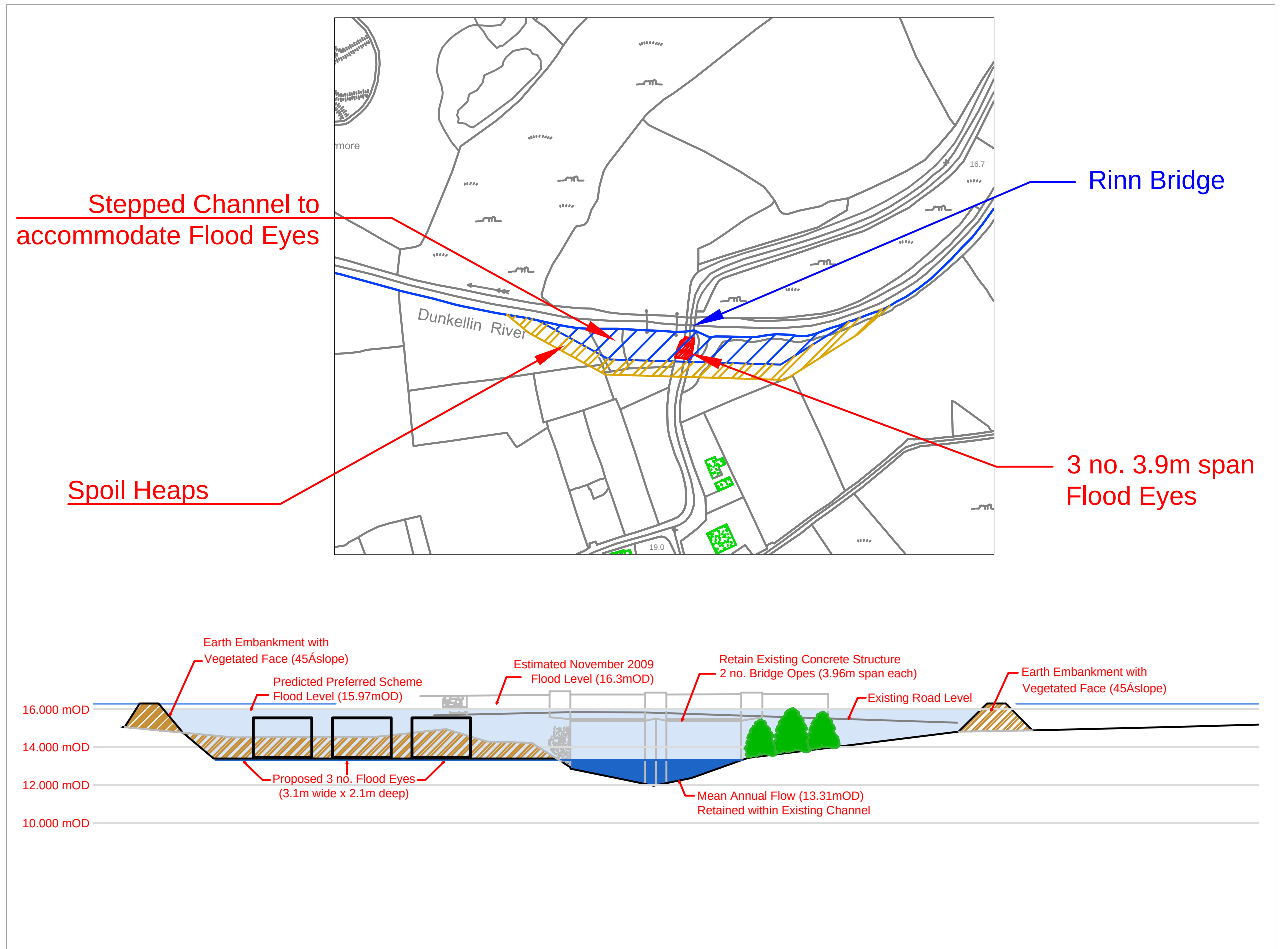
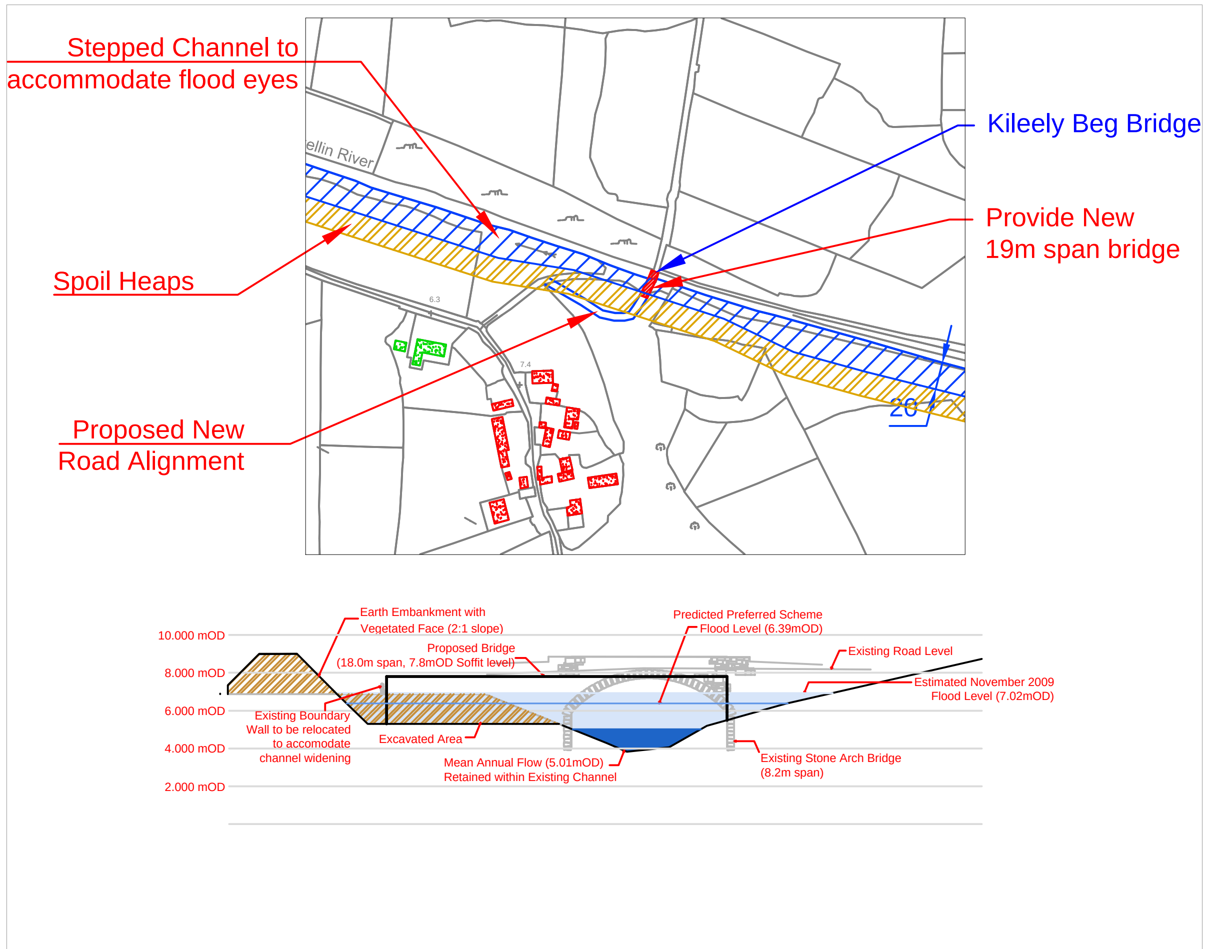
Drawing No.: 6408-2210

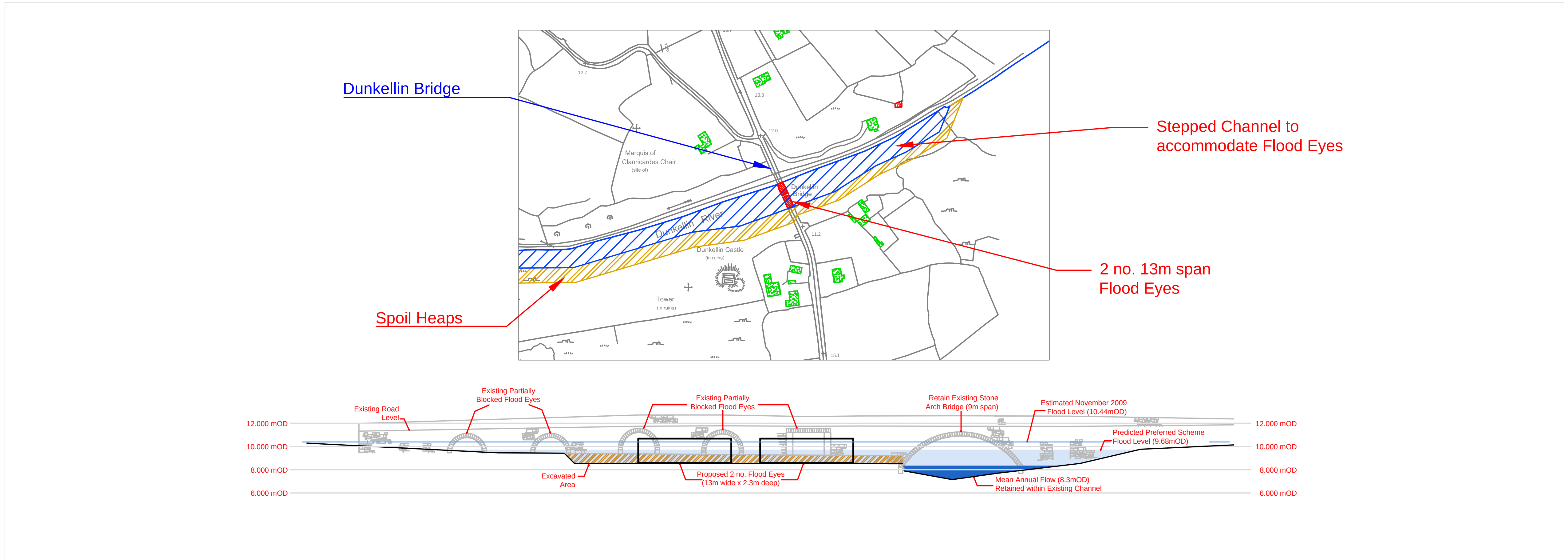
Revision: C



Rinn Bridge



Killeely Beg Bridge



Dunkellin Bridge

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Rev	Date	Description	By	Chkd.
C	Sept/14	Issue	CK	MMcD

Client: Galway County Council

Project: Dunkellin River and Aggard Stream Flood Relief Scheme

Title: Proposed Works at Bridges on the Dunkellin River Sheet 2 of 2

Scale @ A1: Elevation 1:200 Plan 1:2500
Scale @ A3: Elevation 1:400 Plan 1:5000

Prepared by: PMF | Checked: MMcD | Date: Oct 2011

Project Director: Michael Garrick

Drawing Status:

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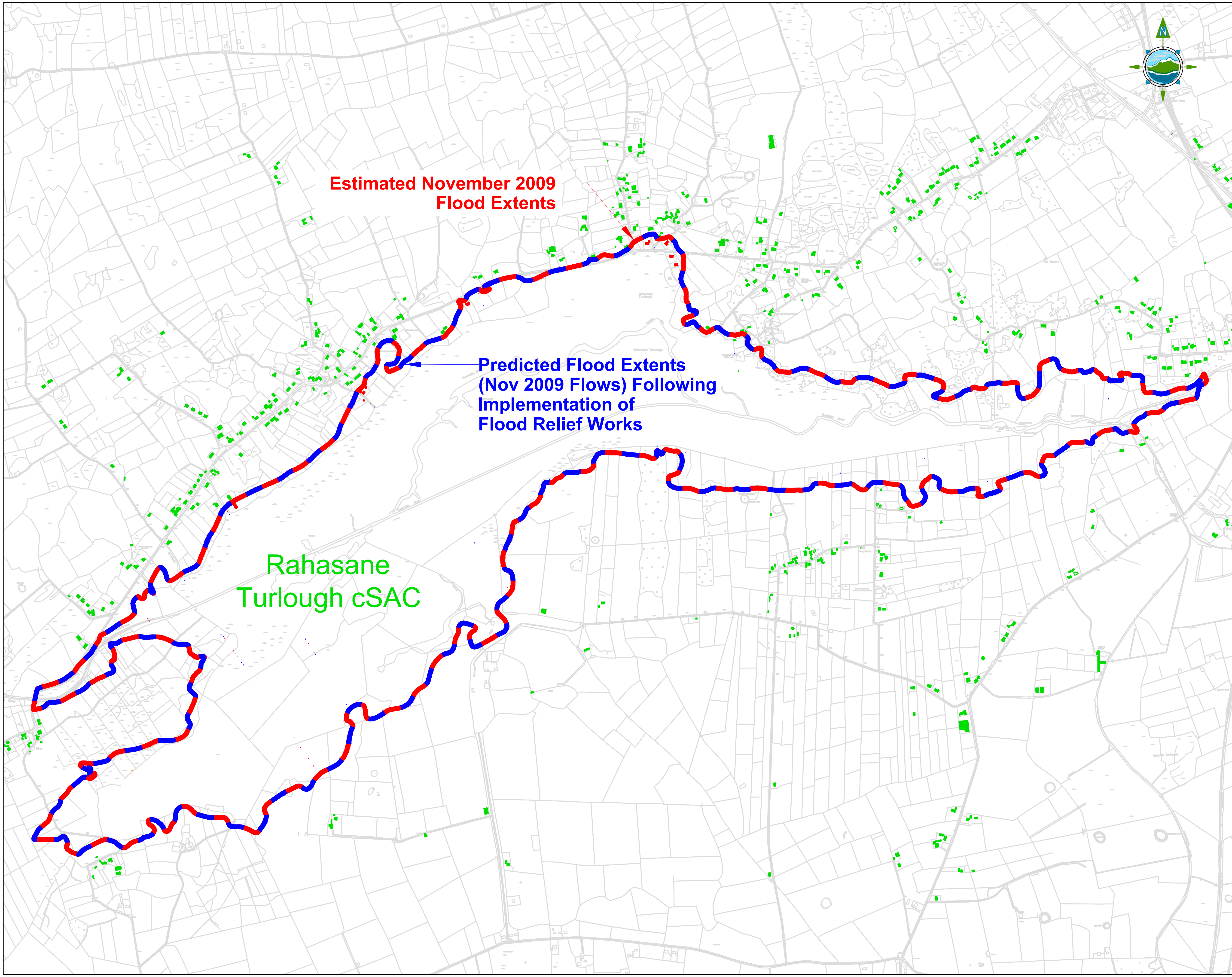
Drawing No.: 6408-2211 Revision: C



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E	July/14	Issue	CK	MMcD
Rev	Date	Description	By	Chkd.

Client: Galway County Council

Project: Dunkellin River and Aggard Stream Flood Relief Scheme

Title: Predicted Water Levels for November 2009 flood event Pre & Post Flood Alleviation Works

Scale @ A1: 7,500
Scale @ A3: 15,000

Prepared by: PMF
Checked: MMcD
Date: October 2011

Project Director: Michael Garrick

Drawing Status:

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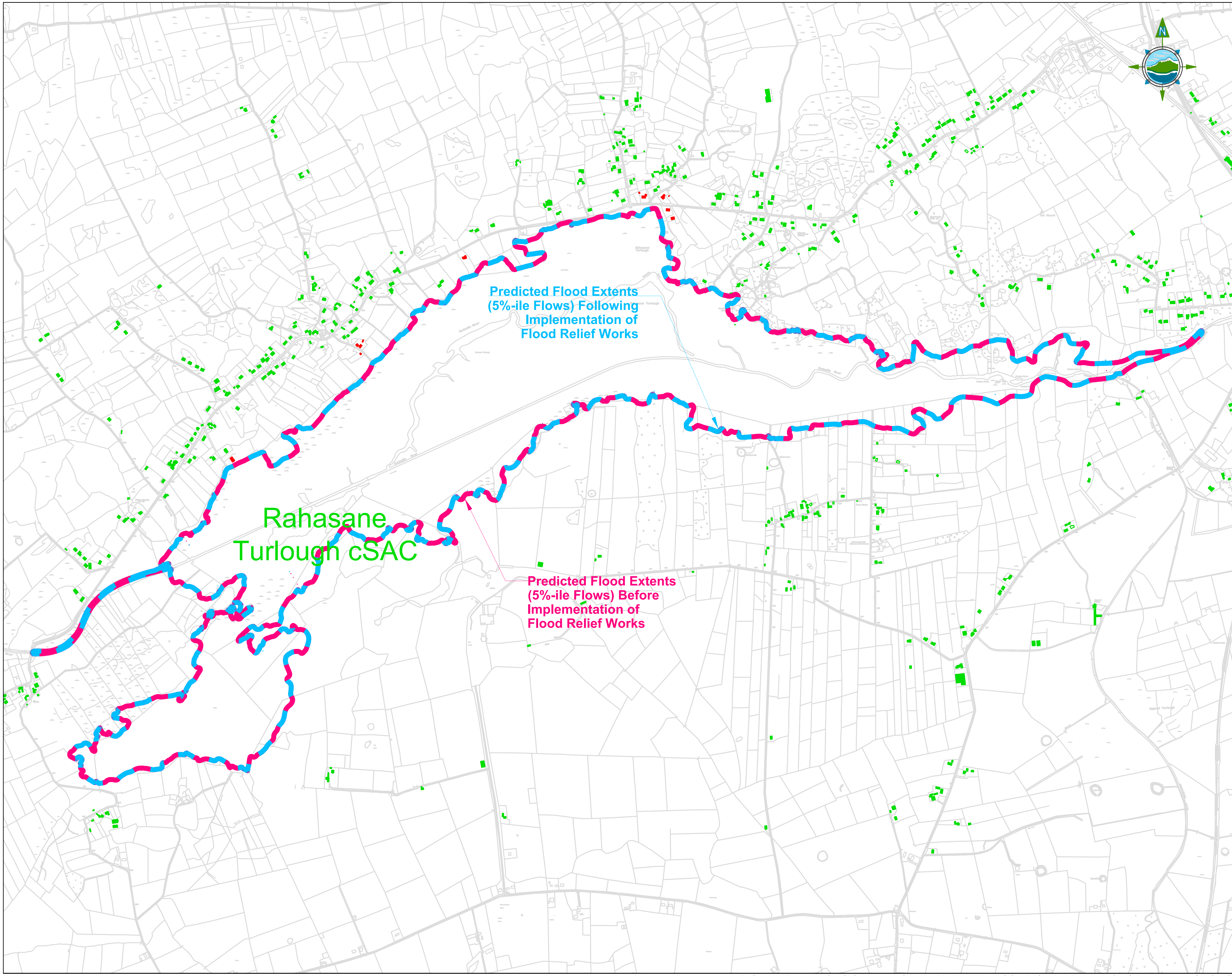
Drawing No.: 6408-2215

Revision: E



NOTES:

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Rev	Date	Description	By	Chkd.
D	July/14	Issue	CK	MMcD

Client: Galway County Council

Project: Dunkellin River and Aggard Stream Flood Relief Scheme

Title: Predicted Water Levels for 5%-ile Flows Pre & Post Flood Alleviation Works

Scale @ A1: 7,500
Scale @ A3: 15,000

Prepared by:	Checked:	Date:
PMF	MMcD	October 2011

Project Director: Michael Garrick

Drawing Status:

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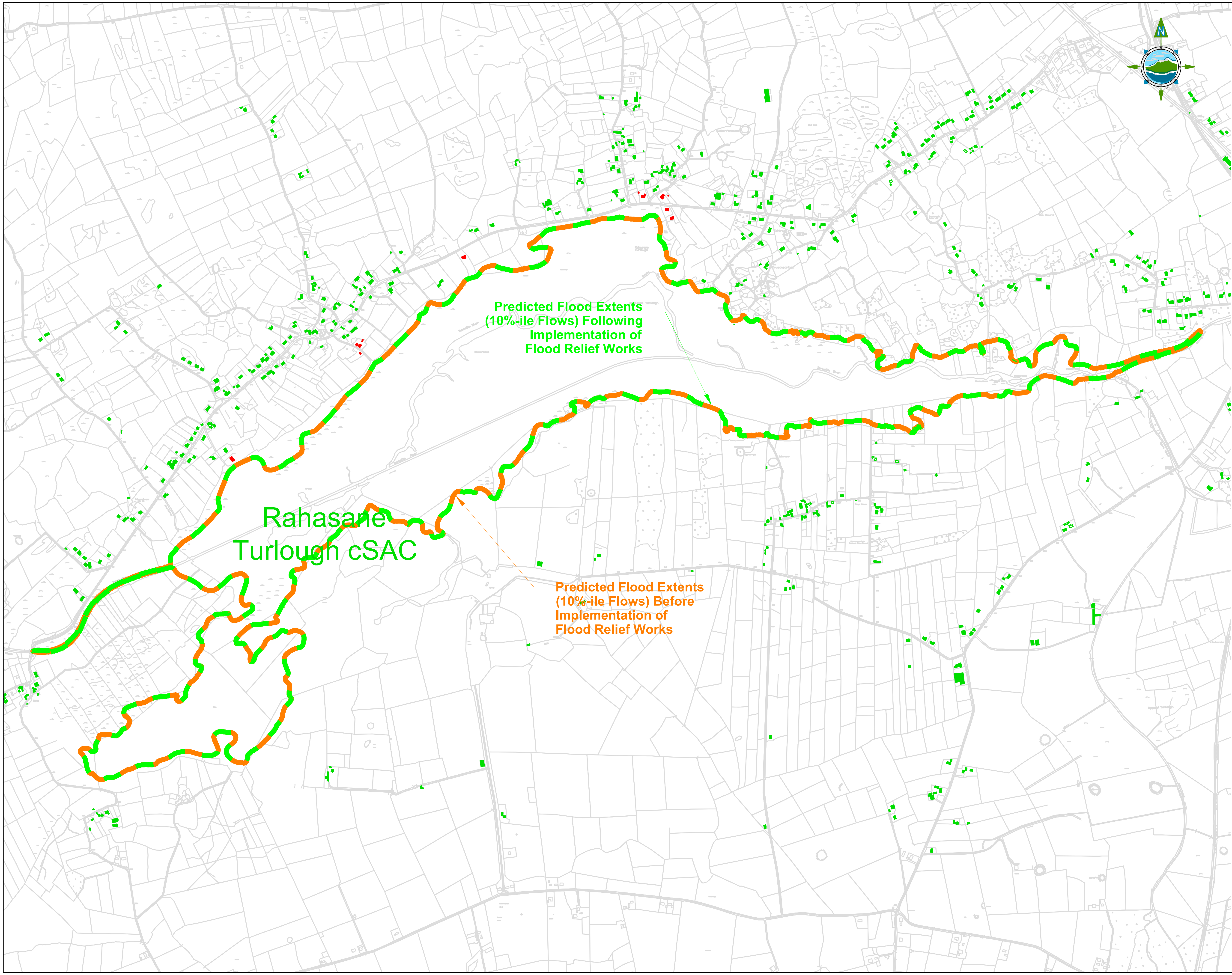
Drawing No.: 6408-2216

Revision: D



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1. FIGURED DIMENSIONS ONLY TO BE TAKEN FROM THIS DRAWING.
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D	July/14	Issue	CK	MMcD
Rev	Date	Description	By	Chkd.

Client: Galway County Council

Project: Dunkellin River and Aggard Stream Flood Relief Scheme

Title: Predicted Water Levels for 10%-ile Flows Pre & Post Flood Alleviation Works

Scale @ A1: 7,500
Scale @ A3: 15,000

Prepared by:	Checked:	Date:
PMF	MMcD	October 2011

Project Director: Michael Garrick

Drawing Status:

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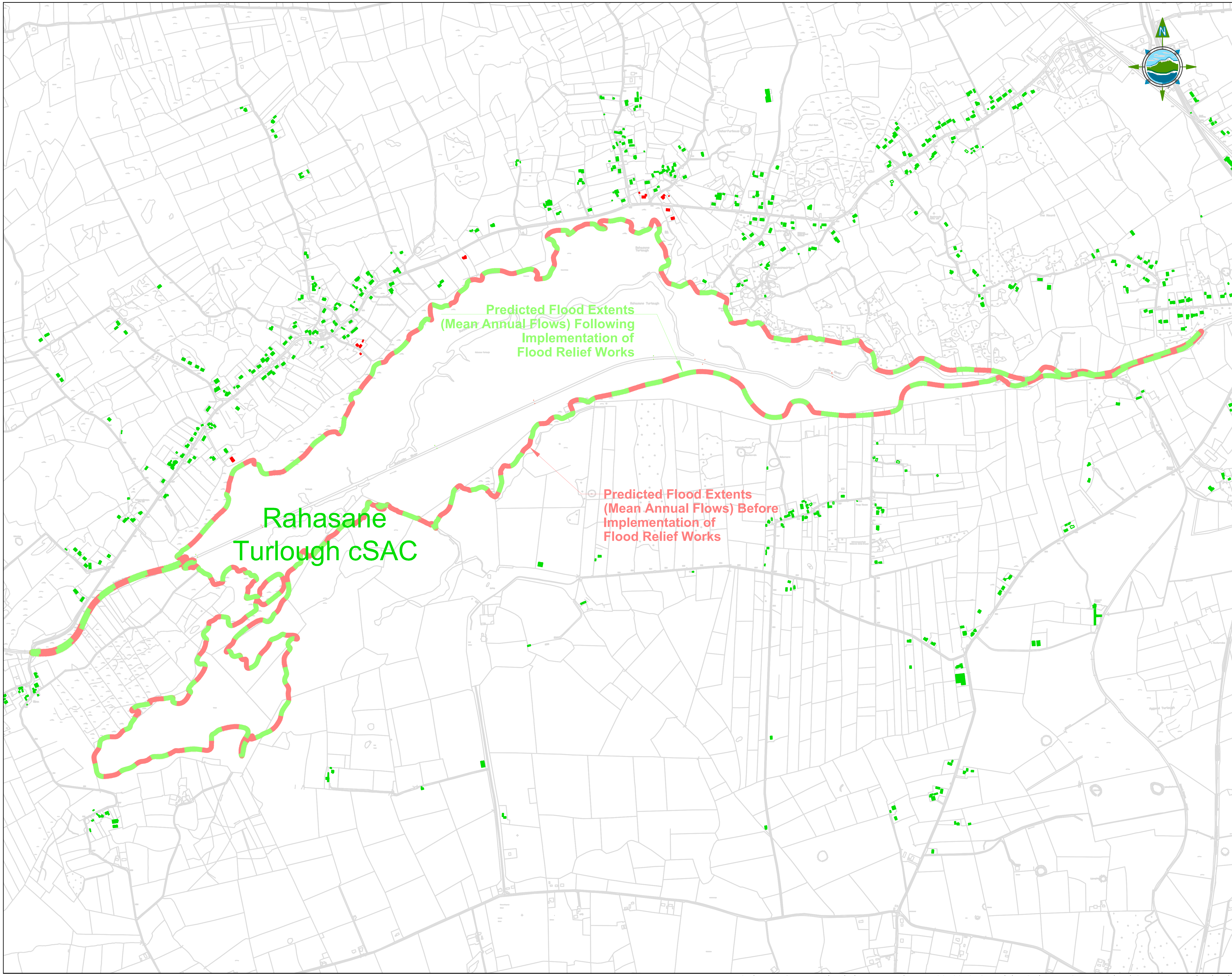
Drawing No.: 6408-2217

Revision: D



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Rev	Date	Description	By	Chkd.
D	July/14	Issue	CK	MMcD

Client: Galway County Council

Project: Dunkellin River and Aggard Stream Flood Relief Scheme

Title: Predicted Water Levels for Mean Annual Flow Conditions Pre & Post Flood Alleviation Works

Scale @ A1: 7,500
Scale @ A3: 15,000

Prepared by: PMF | Checked: MMcD | Date: October 2011

Project Director: Michael Garrick

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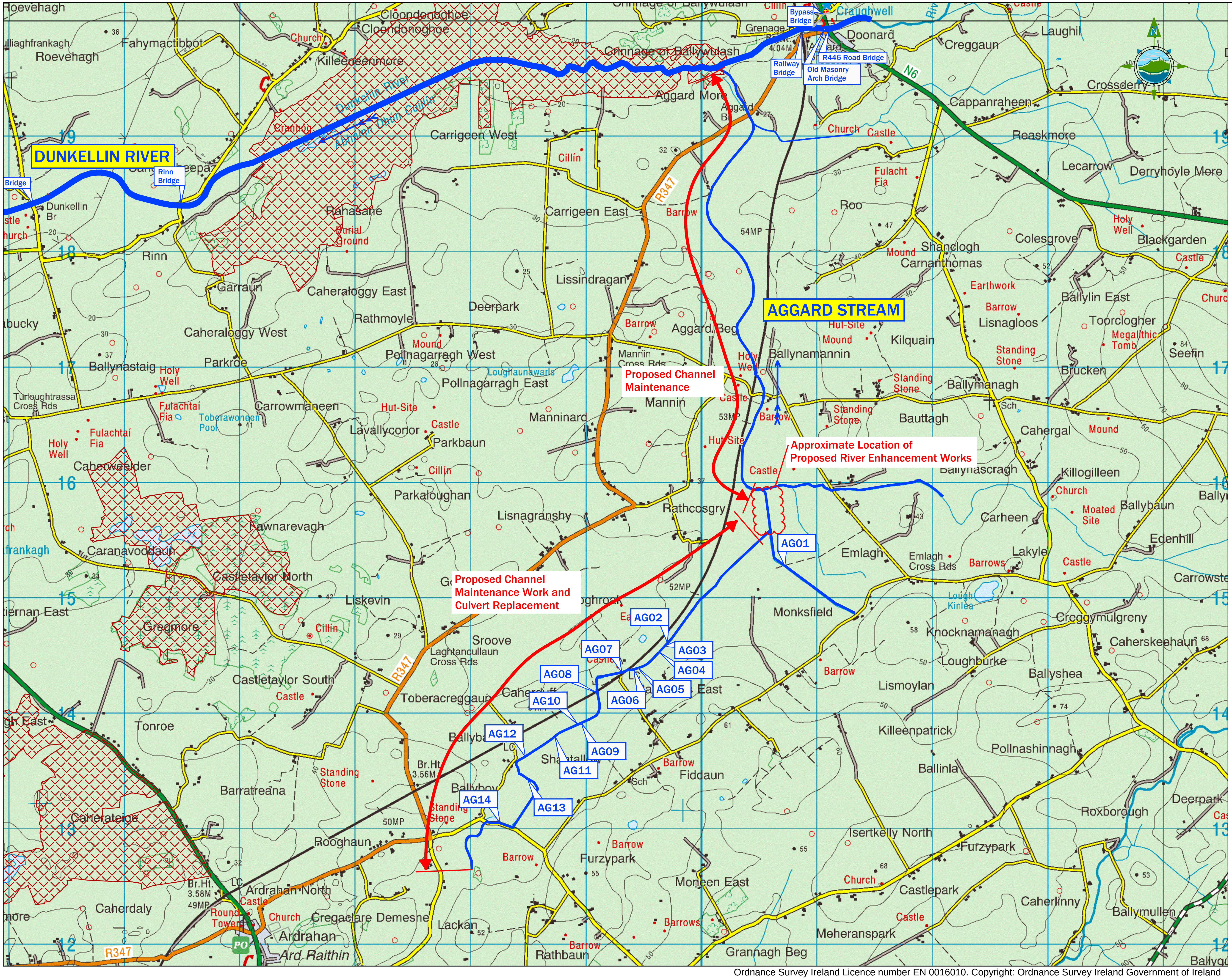
Revision: D



LEGEND

RIVER

SAC's, pNHA's, & SPA

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Rev	Date	Description	By	Chkd.
A	Nov/11	First Issue	PMF	MMcD

Client: Galway County Council

Project: Dunkellin River and Aggard Stream Flood Relief Scheme

Title: Layout Plan of Proposed Works along Aggard Stream

Scale @ A1: 15,000
Scale @ A3: 30,000

Prepared by:	Checked:	Date:
PMF	MMcD	Nov 2011

Project Director: Michael Garrick

Drawing Status:

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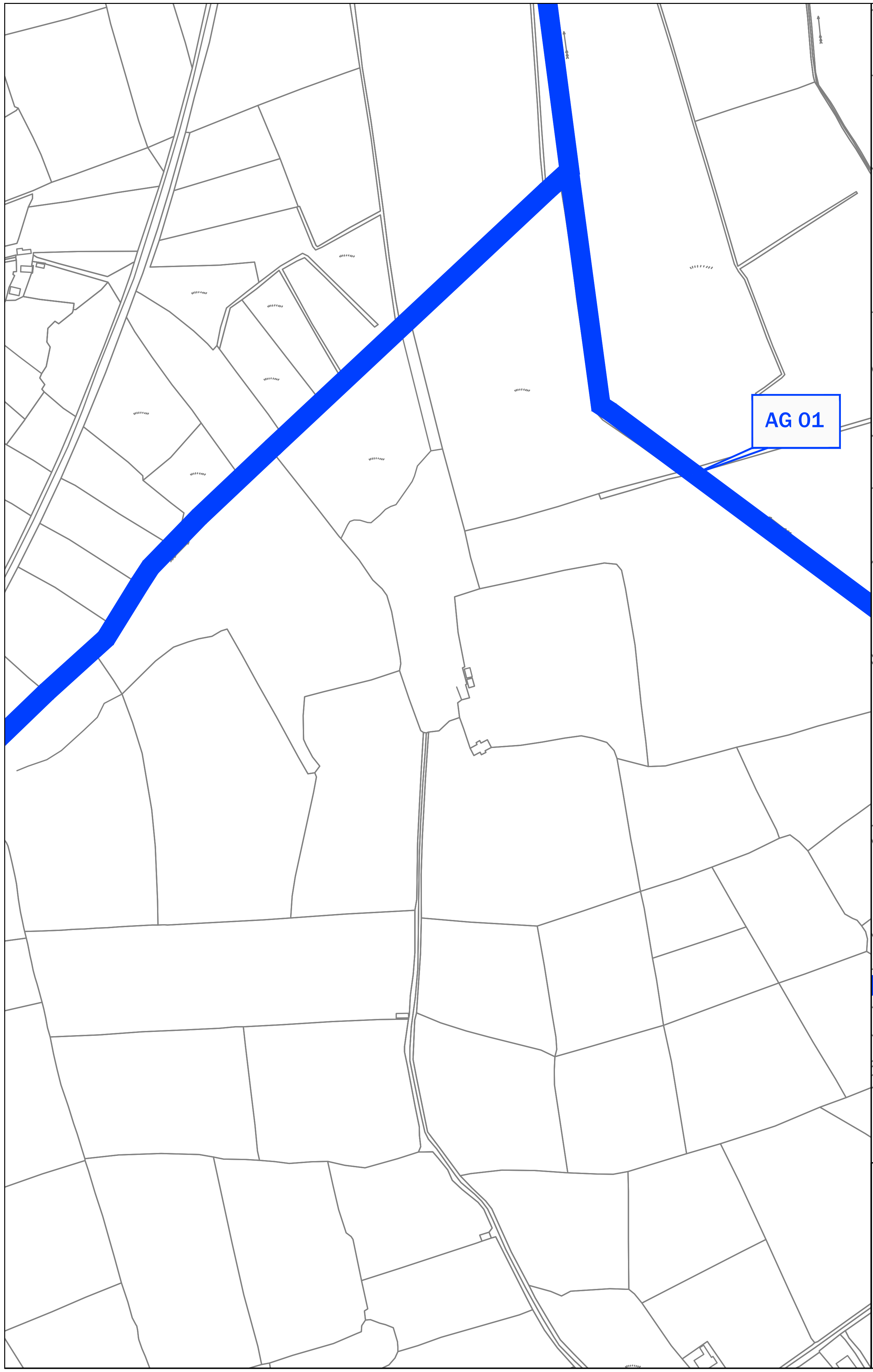
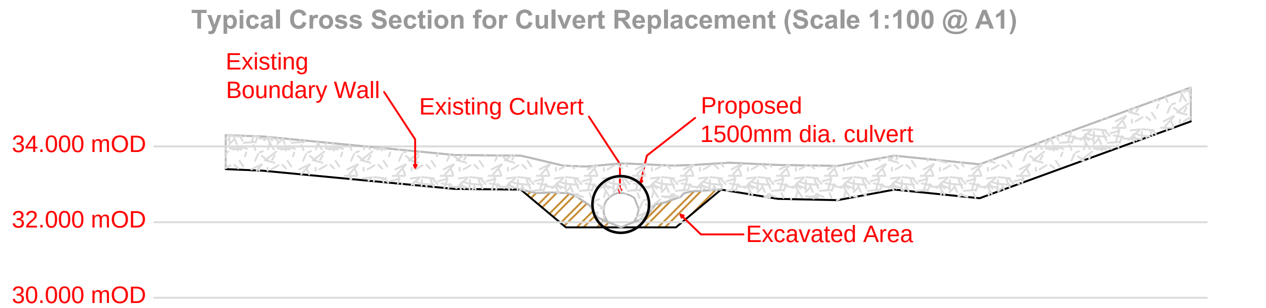
Drawing No.: 6408-2220

Revision: A





LEGEND

RIVER

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C	Sept/14	Issue	CK	PC
Rev	Date	Description	By	Chkd.

Client: Galway County Council

Project: Dunkellin River and Aggard Stream Flood Relief Scheme

Title: Locations of Proposed Culvert Replacement along Aggard Stream Sheet 1 of 2

Scale @ A1: 2500
Scale @ A3: 5000

Prepared by:	Checked:	Date:
PMF	MMcD	Nov 2011

Project Director: Michael Garrick

Drawing Status:

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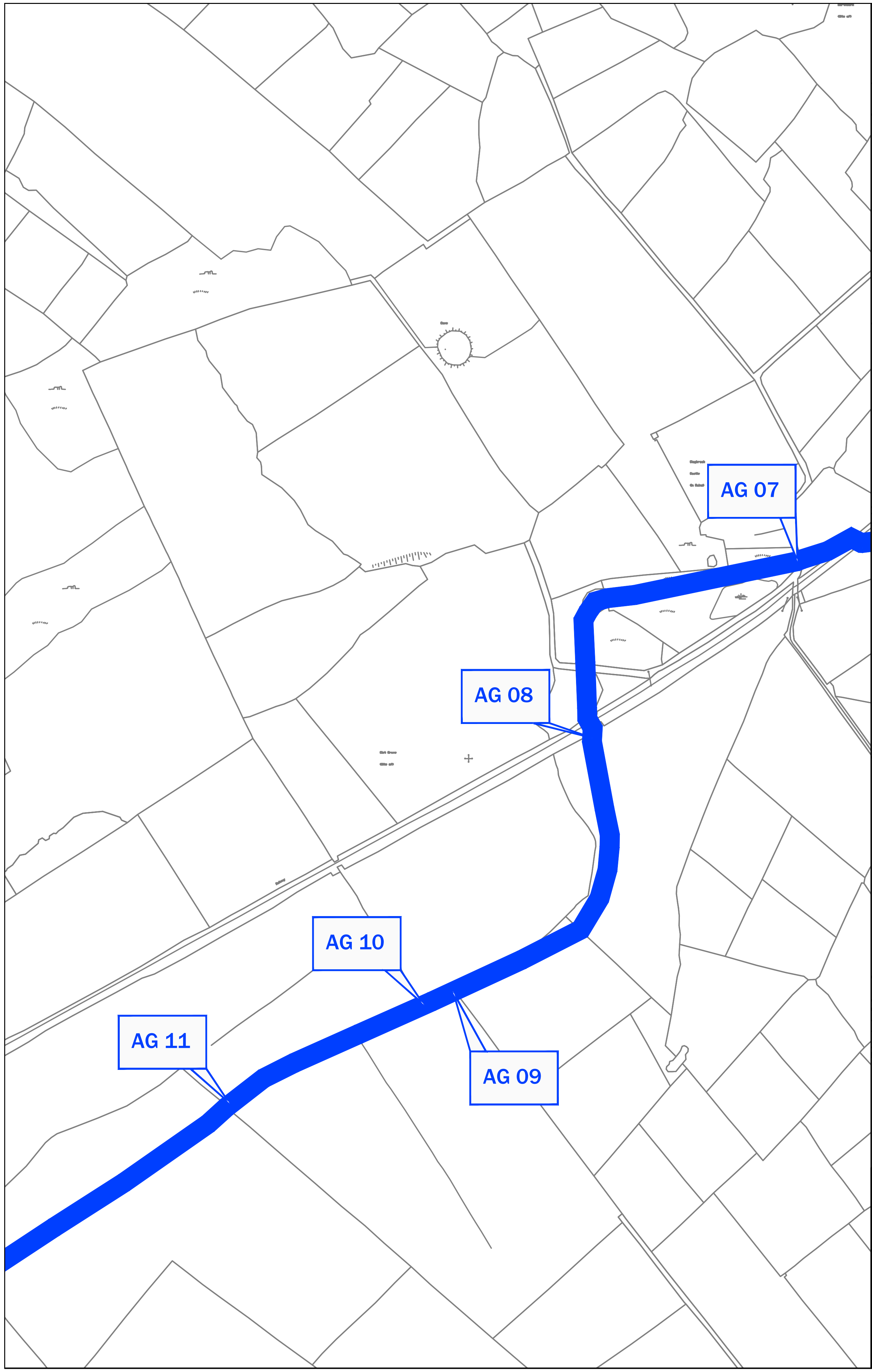
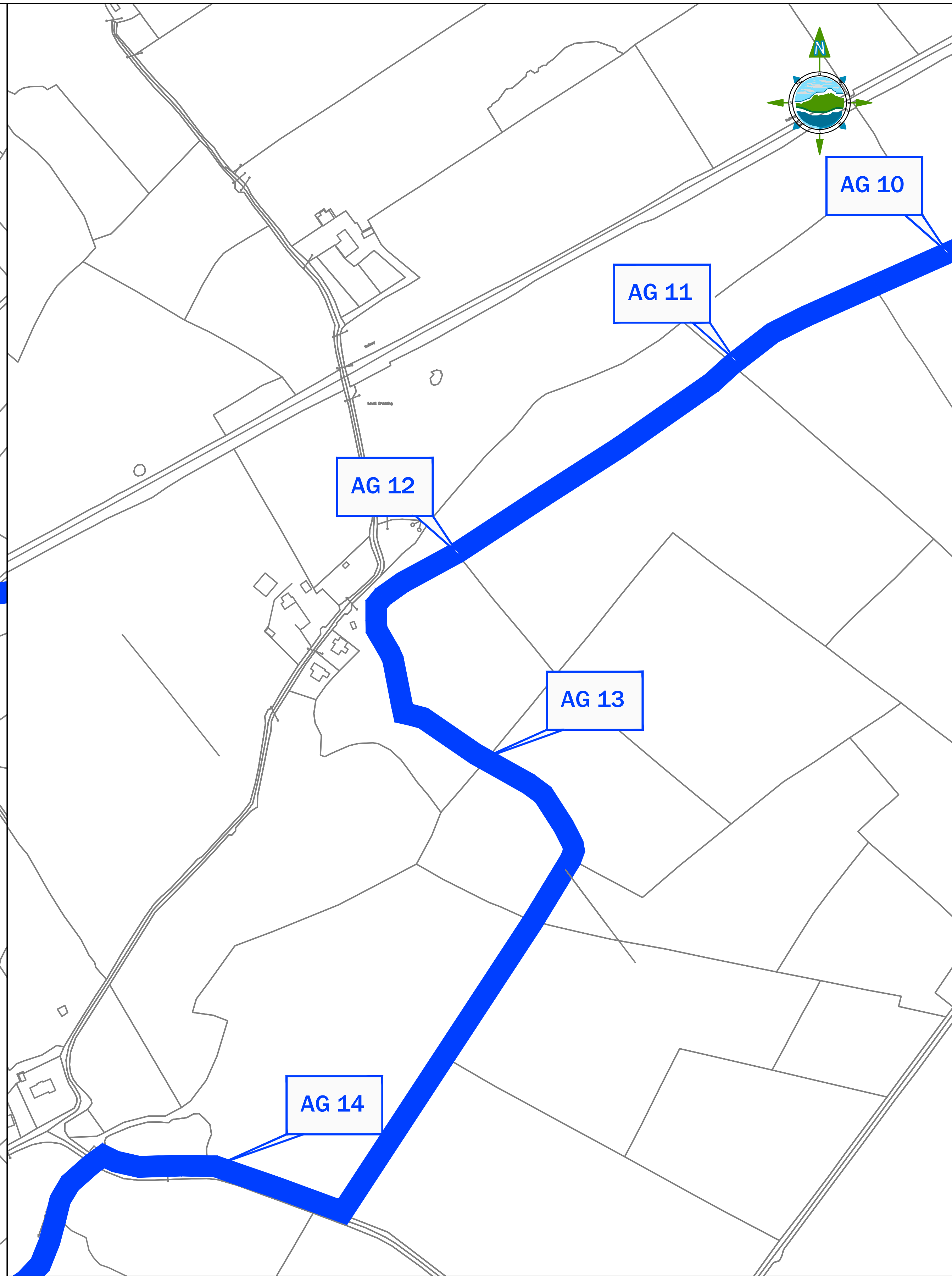
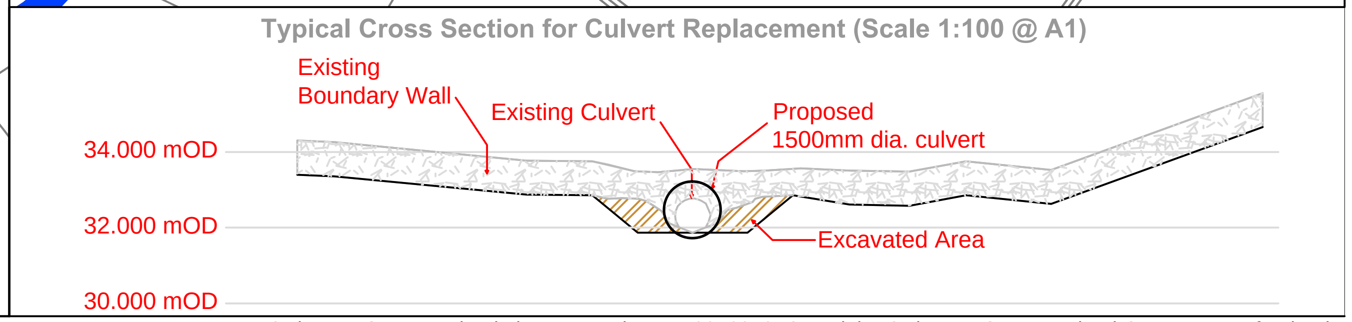
Drawing No.: 6408-2221

Revision: C







LEGEND

RIVER

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C	Sept/14	Issue	CK	PC
Rev	Date	Description	By	Chkd.

Client: Galway County Council

Project: Dunkellin River and Aggard Stream Flood Relief Scheme

Title: Locations of Proposed Culvert Replacement along Aggard Stream Sheet 2 of 2

Scale @ A1: 2500
Scale @ A3: 5000

Prepared by:	Checked:	Date:
PMF	MMcD	Nov 2011

Project Director: Michael Garrick

Drawing Status:

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Revision: C

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LEGEND

RIVER

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Rev	Date	Description	By	Chkd.
A	Sept/14	First Issue	CK	PC

Client: Galway County Council

Project: Dunkellin River and Aggard Stream Flood Relief Scheme

Title: Location of Site Notices

Scale @ A1: 1:17,500
Scale @ A3: 1:35,000

Prepared by:	Checked:	Date:
CK	PC	Sept 14

Project Director: Michael Garrick

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Drawing No.: 6408-2250

Revision: A

APPENDIX B

Terrestrial Ecology

B1 NPWS Site Synopses

Site Name: Rahasane Turlough SAC

Site Code: 000322

Rahasane Turlough lies in gently undulating land, approximately 2 km west of Craughwell, Co. Galway. It consists of two basins which are connected at times of flood but separated as the waters decline. The larger of these, the northern basin, takes the Dunkellin River westwards.

The site is a Special Area of Conservation (SAC) selected for the following habitats and/or species listed on Annex I / II of the E.U. Habitats Directive (* = priority; numbers in brackets are Natura 2000 codes):

[3180] Turloughs*

Rahasane Turlough was formerly the natural sink of the Dunkellin River, but now an artificial channel takes some of the water further downstream. Water escapes the artificial channel to sweep around the northern basin, and again in the west, where it flows into an active swallow-hole system. The main swallow-holes here are constantly changing, but reach 5 m in diameter and 2-3 m deep. Some minor collapses are found elsewhere in the turlough, as well as a small number of more permanent pools. Mostly, the edges of the turlough rise gradually into the surrounding land, but in places, rocks mark a more sudden transition. The southern basin is an impressive feature, with high rocky sides above an undulating base, strewn with boulders. There is a low hill on the south side of the main basin, and another on the north-east, near Shanbally Castle, where smooth limestone pavement is evident. The major part of the turlough is open, flat and grassy, with occasional depressions and dry channels. The substrate consists largely of silty clay with shell fragments, reaching over 3 m in thickness. Locally in the main basin there are signs of marl, but peat is absent everywhere. Like the southern basin, the eastern end of the main (northern) basin is distinguished by the presence of large rocks scattered over the floor.

The vegetation of Rahasane is divided between dry and wet communities. Because of its large catchment, the turlough is naturally eutrophic and this, together with a lack of peat, limits the sedges (*Carex* spp.) which are usually abundant in turlough vegetation. In places with outcropping limestone, the vegetation is predominantly dry grassland with Red Fescue (*Festuca rubra*) and Crested Dog's-tail (*Cynosurus cristatus*), among a generally calcicole community. Large areas in the drier parts of the turlough are covered by a community characterised by an abundance of Creeping Cinquefoil (*Potentilla reptans*), with Common Sedge (*Carex nigra*), Silverweed (*Potentilla anserina*) and Creeping Bent (*Agrostis stolonifera*). Where the soil is less well-drained, Creeping Cinquefoil disappears from this community and the rare species, Fen Violet (*Viola persicifolia*), which is listed in the Irish Red Data Book, occurs. In these areas, the presence of Common Spike-rush (*Eleocharis palustris*) suggests that water is close to the surface.

Wet communities are associated with the river channels and pools. Fully aquatic communities include such species as Fan-leaved Water Crowfoot (*Ranunculus circinatus*), Fennel Pondweed (*Potamogeton pectinatus*), Lesser Pondweed (*P. pusillus*), Fat Duckweed (*Lemna gibba*), Whorled Water-milfoil (*Myriophyllum verticillatum*) and Needle Spike-rush (*Eleocharis acicularis*). Semi-aquatic communities fringe the main channel of the river and colonise muddy pools in the basin. Species such as Lesser Water-parsnip (*Berula erecta*), Fool's Water-cress (*Apium nodiflorum*), River Water-dropwort (*Oenanthe fluviatilis*) and Amphibious Bistort (*Polygonum amphibium*) occur, along with the rare species, Northern Yellow-cress (*Rorippa islandica*), which is listed in the Irish Red Data Book. There are also some narrow fields with Yellow Iris (*Iris pseudacorus*).

There are small areas of scrub on the southern and north-western sides of the turlough, but the area of flooded woodland is small. The scrub is made up of Buckthorn (*Rhamnus cathartica*), Ash (*Fraxinus excelsior*) and Hazel (*Corylus avellana*). The trees support a range of epiphytic mosses such as *Leskea polycarpa, Amblystegium riparium, Isopterygium elegans, Isothecium myosuroides* and *Thuidium tamariscinum*.

Rahasane Turlough is renowned for its wintering wildfowl populations, but it also supports nesting waders in summer, which include Lapwing, Redshank, Snipe and Dunlin. Figures stated in the following account represent mean (and peak) counts obtained during the three seasons, 1984/85 to 1986/87. Internationally important numbers of Whooper Swan 179, Golden Plover 17680, Wigeon 7760 and Shoveler 498 are found. The first two species, together with Bewick's Swan, below, are listed on Annex I of the E.U. Birds Directive. Species recorded in nationally important numbers are Bewick's Swan 132, Mute Swan 125, Teal 3005, Mallard 777, Pintail 102, Pochard 356, Tufted Duck 381, Coot 1289, Lapwing 3995, Dunlin 3569 (5653), Black-tailed Godwit 170 and Curlew 1205. Small numbers of the internationally important Greenland White-fronted Goose regularly overwinter at Rahasane (average count, as above, 59), but numbers have been declining over the years.

There is a small run of Atlantic Salmon (*Salmo salar*) through the Dunkellin River when it is flowing overground. The fish pass through the turlough but do not use it for spawning. This species is listed on Annex II of the E.U. Habitats Directive.

The Fairy Shrimp (*Tanymastix stagnalis*, Class Crustacea) was first recorded in Ireland from the southern basin at Rahasane, though it has since been recorded elsewhere. It requires isolation from predators to grow to reproductive age and so cannot occur in permanent waterbodies.

The turlough is closely grazed by cattle, sheep and horses. Grazing is a critical factor in maintaining a balance between open swards and woodland development at the edges of the turlough. Drainage is a major threat to turloughs, but the Dunkellin

River has not been arterially drained. The river was straightened many years ago where it crosses the turlough, and the artificial channel was dredged again in 1992, but this does not appear to have affected winter flooding. Some degree of artificial enrichment of the basin is occurring from the farming areas upstream, and local enrichment is associated with grazing practices. Eutrophication is among the major threats to turlough systems in general.

Rahasane Turlough is of major ecological significance as one of only two large turloughs in the country which still function naturally. It is the most important turlough in Ireland for birdlife. In a relatively recent national survey, it was also rated very highly for its vegetation, and supports two rare species listed in the Irish Red Data Book. Turloughs are a rare habitat type and are given priority status under Annex I of the E.U. Habitats Directive.

SITE SYNOPSIS

SITE NAME: RAHASANE TURLOUGH SPA

SITE CODE: 004089

Rahasane Turlough lies in gently undulating land, approximately 2 km west of Craughwell, Co. Galway. It consists of two basins which are connected at times of flood but separated as the waters recede. The larger of these, the northern basin, takes the Dunkellin River westwards. Rahasane was formerly the natural sink of the Dunkellin River, but now an artificial channel takes some of the water further downstream. Water escapes the artificial channel to sweep around the northern basin, and again in the west, where it flows into an active swallowhole system. Some minor collapses are found elsewhere in the turlough, as well as a small number of more permanent pools. Mostly, the edges of the turlough rise gradually into the surrounding land, but in places rocks mark a more sudden transition. The southern basin has high rocky sides above an undulating base that is strewn with boulders. There is a low hill on the south side of the main basin, and another on the north-east, near Shanbally Castle. The major part of the turlough is open, flat and grassy, with occasional depressions and dry channels. The substrate consists largely of silty clay. Locally in the main basin there are signs of marl, but peat is absent everywhere.

The vegetation of Rahasane is divided between dry and wet communities. Because of its large catchment, the turlough is naturally eutrophic and this, together with a lack of peat, limits the sedges (*Carex* spp.) which are usually abundant in turlough vegetation. In places with outcropping limestone, the vegetation is predominantly dry grassland among a generally calcicole community. Large areas in the drier parts of the turlough are covered by a community characterised by an abundance of Creeping Cinquefoil (*Potentilla reptans*), with Common Sedge (*Carex nigra*), Silverweed (*Potentilla anserina*) and Creeping Bent (*Agrostis stolonifera*). Where the soil is less well-drained, Creeping Cinquefoil disappears from this community and the rare, Red Data Book species, Fen Violet (*Viola persicifolia*), occurs. The wet communities are all associated with the river channels and pools. Fully aquatic communities include such species as Fan-leaved Water-crowfoot (*Ranunculus circinatus*) and pondweeds (*Potamogeton* spp.). Semi-aquatic communities fringe the main channel of the river and colonise muddy pools in the basin. Species such as Lesser Water-parsnip (*Berula erecta*), Fool's Water-cress (*Apium nodiflorum*) and Amphibious Bistort (*Polygonum amphibium*) occur, as well as the rare, Red Data Book species, Northern Yellow-cress (*Rorippa islandica*). There are also some narrow fields with Yellow Iris (*Iris pseudacorus*). There are small areas of scrub on the southern and north-western sides of the turlough, but the area of flooded woodland is small.

Rahasane is considered to be the most important turlough in the country for wintering waterfowl. It is a traditional site for Greenland White-fronted Goose, and supports a population of national importance (218 individuals) - all figures are average peaks for the period 1995/96-1999/00. It also has nationally important populations of Whooper Swan (141), Wigeon (3,630), Pintail (21), Golden Plover (6,626), Lapwing (2,220) and Black-tailed Godwit (435). The Shoveler population (29) is very close to the threshold for national importance. The site has the largest inland population of Dunlin (864) in the country, and also supports Mute Swan (76), Teal (367), Tufted Duck (32), Curlew (197), Redshank (149), Mallard (124), Black-headed Gull (280) and Grey Heron (31). As at all turlough sites, numbers of birds present can vary considerably owing to fluctuations in water levels. The site has long been known as an important waterfowl site and has been monitored annually in recent years.

The Crustacean, Fairy Shrimp (*Tanymastix stagnalis*) was first recorded in Ireland from the southern basin at Rahasane, though it has since been noted elsewhere. It requires isolation from predators to grow to reproductive age and so does not occur in permanent waterbodies.

Arterial drainage, whilst probably now unlikely to occur, would cause serious damage to the flooding pattern of this turlough and would be expected to affect the bird populations. The Greenland White-fronted Goose population is particularly vulnerable to habitat degradation as the flock has only one alternative feeding site (at Cregganna). Some degree of artificial enrichment of the basin is occurring from the farming areas upstream, and local enrichment is associated with grazing practices at the site; however, the bird populations are unlikely to be affected by such activities. The turlough is closely grazed by cattle, sheep and horses, and grazing is a critical factor in maintaining a balance between open swards and woodland development at the edges of the turlough.

Rahasane Turlough SPA is of high ornithological importance and supports seven species of national importance. The Wigeon and Golden Plover populations are of particular note as they each represent approximately 4% of the national totals of these species. The occurrence of Greenland White-fronted Goose, Whooper Swan and Golden Plover is of importance as these species are listed on Annex I of the E.U. Birds Directive.

1.12.2004

Site Name: Galway Bay Complex SAC

Site Code: 000268

Situated on the west coast of Ireland, this site comprises the inner, shallow part of a large bay which is partially sheltered by the Aran Islands. The Burren karstic limestone fringes the southern sides and extends into the sublittoral. West of Galway city the bedrock geology is granite. There are numerous shallow and intertidal inlets on the eastern and southern sides, notably Muckinish, Aughinish and Kinvarra Bays. A number of small islands composed of glacial deposits are located along the eastern side. These include Eddy Island, Deer Island and Tawin Island. A diverse range of marine, coastal and terrestrial habitats, including several listed on Annex I of the E.U. Habitats Directive, occur within the site, making the area of high scientific importance.

The site is a Special Area of Conservation (SAC) selected for the following habitats and/or species listed on Annex I / II of the E.U. Habitats Directive (* = priority; numbers in brackets are Natura 2000 codes):

[1140] Tidal Mudflats and Sandflats
[1150] Coastal Lagoons*
[1160] Large Shallow Inlets and Bays
[1170] Reefs
[1220] Perennial Vegetation of Stony Banks
[1310] *Salicornia* Mud
[1330] Atlantic Salt Meadows
[1410] Mediterranean Salt Meadows
[3180] Turloughs*
[5130] Juniper Scrub
[6210] Orchid-rich Calcareous Grassland*
[7210] *Cladium* Fens*
[7230] Alkaline Fens
[1355] Otter (*Lutra lutra*)
[1365] Common (Harbour) Seal (*Phoca vitulina*)

Galway Bay South holds a very high number of littoral communities (12). They range from rocky terraces, to sandy beaches with rock or sand dunes behind. The intertidal sediments of Galway Bay support good examples of communities that are moderately exposed to wave action. A well-defined talitrid amphipod zone in the upper shore gives way to an intertidal, mid shore zone with sparse epifauna or infauna. On the lower, flat part of the shore, the tubes of the deposit-feeding terebellid worm, *Lanice conchilega*, are common on the surface. Nereid and cirratulid polychaete worms (*Hediste diversicolor*, *Arenicola marina*), small crustaceans and bivalves (*Angulus tenuis*, *Cerastoderma edule* and *Macoma balthica*) are present. The area has the country's only recorded example of the littoral community characterized by *Fucus serratus* with sponges, ascidians and red seaweeds on tide-swept lower eulittoral mixed substrata. This community has very high species richness (85 species), as do the sublittoral fringe communities on the Finavarra reef (88 species). The rare Purple Sea Urchin *Paracentrotus lividus* and the foliose red alga *Phyllophora sicula* are present at Finavarra, whereas the red alga *Rhodymenia delicatula* and the rare brown alga, *Ascophyllum nodosum* var. *mackii,* occur in Kinvarra and Muckinish Bays. Sublittorally, the area has a number of distinctive and important communities. Of particular note is that Ireland's only reported piddock (bivalve mollusc) bed thrives in the shallows of Aughinish Bay. The rare sponge, *Mycale contarenii,* is also found here. There is further interest in an extensive maerl bed of *Phymatolithon calcareum* which occurs in the strong tidal currents of Muckinish Bay. There is also maerl off Finavarra Point and in Kinvarra Bay (*Lithothamnion corallioides*, *Lithophyllum dentatum* and *Lithophyllum fasciculatum*). An oyster bed in Kinvarra Bay and seagrass (*Zostera* spp.) beds off Finavarra Point are also important features. Other significant habitats which occur include secondary maerl beds and communities strongly influenced by tidal streams.

Saltmarshes are frequent within this extensive coastal site, with both E.U. Habitats Directive types, 'Atlantic Salt Meadow' and 'Mediterranean Salt Meadow' well represented. Most of the saltmarshes are classified as the bay type, with the substrate being mud or mud/sand. There is one lagoon type and one estuary type. Lagoon saltmarshes are the rarest type found in Ireland. The best examples of saltmarsh are located in inner Galway bay, east of a line running between Galway city and Kinvarra. In this area the coastline is highly indented, thus providing the sheltered conditions necessary for extensive saltmarsh development. Common saltmarsh species include Thrift (*Armeria maritima*), Red Fescue (*Festuca rubra*), Common Scurvygrass (*Cochlearia officinalis*), Lax-flowered Sea-lavender (*Limonium humile*), Common Saltmarsh-grass (*Puccinellia maritima*), Saltmarsh Rush (*Juncus gerardi*) and Sea Rush (*Juncus maritimus*). On the lower levels of the saltmarshes and within pans there occurs Glasswort (*Salicornia europaea* agg.). A noteworthy feature of the saltmarsh habitat within this site is the presence of dwarfed brown seaweeds in the vegetation. These are also known as "turf fucoids" and typical species include *Fucus* spp., *Ascophyllum nodosum* and *Pelvetia canaliculata*. A number of locally rare vascular plant species also grow in saltmarsh areas within the site. These include Reflexed Saltmarsh-grass (*Puccinellia distans*) and Sea-purslane (*Halimione portulacoides*), which are both relatively rare in the western half of the country.

Shingle and stony beaches can be found throughout the site, with the best examples along the more exposed shores to the south and west of Galway city and to the north and east of Finavarra, Co. Clare. In general, these shingle shorelines are sparsely vegetated and frequently occur interspersed with areas of sandy beach and/or bedrock shore. The associated flora is dominated by plant species of frequently disturbed maritime habitats. To the south and west of Galway city, typical plants include Curled Dock (*Rumex crispus*), Common Couch (*Elymus repens*), Sea Sandwort (*Honkenya peploides*), Sea Beet (*Beta vulgaris* subsp. *maritima*), Sea Mayweed (*Matricaria maritima*), Silverweed (*Potentilla anserina*) and Oraches (*Atriplex* spp.). Two rare plant species are associated with the habitat: Henbane (*Hyoscyamus niger*), a threatened species listed in the Irish Red Data Book, grows on shingle beach to the south of Lough Atalia; there are also old records for the threatened plant species Sea-kale (*Crambe maritima*).

An excellent range of lagoons of different types, sizes and salinities occurs within the site. This habitat is given priority status on Annex I of the E.U. Habitats Directive. One unusual type of lagoon, karstic rock lagoon, is particularly well represented. This type of lagoon is common on the Aran Islands, but on mainland Ireland, all but one are confined to this site. Additionally, the best example of all karstic lagoons in the country, Lough Murree, is found at this site. The flora of the habitat is rich and diverse, reflecting the range of salinities in the different lagoons. It is typically brackish, with two species of Tasselweed (*Ruppia* spp.), two Red Data charophytes *Chara canescens* and *Lamprothamnion papulosum*, and *Chaetomorpha linum*, an alga (all lagoonal specialists). The fauna of the lagoon is also rich, diverse and lagoonal. At least 10 lagoonal specialist species were recorded in 1996 and 1998 from the combined habitat of all the lagoons, which is one of the highest number for any lagoonal habitat in the country. Many of the species appear to be rare. The lagoons within this site are excellent examples of the habitat type and of high conservation importance.

Other terrestrial habitats within this site which are of conservation importance include Great Fen-sedge (*Cladium mariscus*)-dominated fen and Black Bog-rush (*Schoenus nigricans*)-dominated alkaline fen at Oranmore, a turlough of moderate size at Ballinacourty, limestone pavement mainly along the southern shore, dry calcareous grassland with orchids (best examples occurring west of Salthill), Juniper (*Juniperus communis*) scrub formations at Oranmore, wet grassland and an area of deciduous woodland at Barna. The orchid-rich grassland occurs on a serious of small drumlin hills found to the west of Galway City, and is largely confined to the sides of the hills. Calcicole pecies such as Kidney Vetch (*Anthyllis vulneraria*), Harebell (*Campanula rotundifolia*), Spring Gentian (*Gentiana verna*), Common Spotted-orchid (*Dactylorhiza fuchsii*), Lesser Twayblade (*Listera ovata*), Pyramidal Orchid (*Anacamptis pyramidalis*), Yellow-wort (*Blackstonia perfoliata*) and Greater Knapweed (*Centaurea scabiosa*) are found here, among others. Juniper is also found in this area.

Areas of alkaline and *Cladium* fen as best represented near Oranmore, and species such as Great Fen-sedge, Common Reed (*Phragmites australis*), Purple Moor-grass (*Molinia caerulea*), Bogbean (*Menyanthes trifoliata*) and Long-stalked Yellow-sedge (*Carex lepidocarpa*) are found along with the usually dominant, Black Bog-rush. The turlough at Ballinacourty floods to about 25 ha in winter, and has vegetation with a typical zonation. Wetland species such as Amphibious Bistort (*Polygonum amphibium*), Common Marsh-bedstraw (*Galium palustre*) and Marsh Cinquefoil (*Potentilla palustris*) are found near the swallow-hole, with species of wet grassland close to the flood limit (e.g. Silverweed, *Potentilla anserina,* Water Mint, *Mentha* *aquatica* and Creeping Bent, *Agrostis stolonifera*). Sedges (*Carex* spp.) dominate in between.

Inner Galway Bay provides extensive good quality habitat for Common Seal (maximum count of 317 in the all-Ireland survey of 2003). This species is listed on Annex II of the E.U. Habitats Directive. The seals use a range of haul-out sites distributed through the bay - these include inner Oranmore Bay, Rabbit Island, St. Brendan's Island, Tawin Island, Kinvarra Bay, Aughinish Bay and Ballyvaughan. The site provides optimum habitat for Otter, also an Annex II-listed species.

Galway Bay is a very important ornithological site. The shallow waters provide excellent habitat for Great Northern Divers (35), Black-throated Divers (28), Scaup (39), Long-tailed Duck (27) and Red-breasted Merganser (232). (Figures given are peak average maxima over the 3 winters 1994/95 to 1996/97). All of these populations are of national importance. The intertidal areas and shoreline provides feeding and roosting habitat for wintering waterfowl, with Brent Goose (517) having a population of international importance and a further 11 species having populations of national importance. Four of the regular wintering species are listed on Annex I of the E.U. Birds Directive - Golden Plover, Bar-tailed Godwit and the two diver species. Breeding birds are also of importance, with significant populations of Sandwich Terns (81 pairs in 1995) and Common Terns (99 pairs in 1995), both also being listed on Annex I of the E.U. Birds Directive. A large Cormorant colony (approx. 300 pairs in 1989) occurs on Deer Island.

Fishing and aquaculture are the main commercial activities within the site. A concern is that sewage effluent and detritus of the aquaculture industry could be deleterious to benthic communities. Reef and sediment communities are vulnerable to disturbance or compaction from tractors accessing oyster trestles. The *Paracentrotus lividus* populations have been shown to be vulnerable to over-fishing. Extraction of maerl in Galway Bay is a threat. Owing to the proximity of Galway city, shoreline and terrestrial habitats are under pressure from urban expansion and recreational activities. Eutrophication is probably affecting some of the lagoons and is a continued threat. Drainage is a general threat to the turlough and fen habitats. Bird populations may be disturbed by aquaculture activities.

This large coastal site is of immense conservation importance, with many habitats listed on Annex I of the E.U. Habitats Directive, four of which have priority status (lagoon, *Cladium* fen, turlough and orchid-rich calcareous grassland). The examples of shallow bays, reefs, lagoons and saltmarshes found within this site are amongst the best in the country. The site supports an important Common Seal colony and a breeding Otter population (Annex II species), and six regular Annex I E.U. Birds Directive species. The site also has four Red Data Book plant species, plus a host of rare or scarce marine and lagoonal animal and plant species.

SITE SYNOPSIS

SITE NAME: INNER GALWAY BAY SPA

SITE CODE: 004031

Galway Bay SPA is a very large, marine-dominated, site situated on the west coast of Ireland. The inner bay is protected from exposure to Atlantic swells by the Aran Islands and Black Head. Subsidiary bays and inlets (e.g. Poulnaclough, Aughinish and Kinvarra Bays) add texture to the patterns of water movement and sediment deposition, which lends variety to the marine habitats and communities. The terraced Carboniferous (Viséan) limestone platform of the Burren sweeps down to the shore and into the sublittoral. The long shoreline is noted for its diversity, with complex mixtures of bedrock shore, shingle beach, sandy beach and fringing salt marshes. Intertidal sand and mud flats occur around much of the shoreline, with the largest areas being found on the sheltered eastern coast between Oranmore Bay and Kinvarra Bay. A number of small islands composed of glacial deposits are included, such as Deer Island, along with some rocky islets.

The southern part of Galway Bay holds a very high number of littoral communities. They range from rocky terraces to sandy beaches with rock or sand dunes behind. The intertidal sediments of Galway Bay support good examples of communities that are moderately exposed to wave action. A well-defined talitrid zone in the upper shore gives way to an intertidal, mid-shore zone with sparse epifauna or infauna. On the lower, flat part of the shore, the tubes of the deposit-feeding terebellid worm, *Lanice conchilega*, are common on the surface. Nereid and cirratulid polychaete worms (*Hediste diversicolor*, *Arenicola marina*), small crustaceans and bivalves (*Angulus tenuis*, *Cerastoderma edule* and *Macoma balthica*) are present. Sublittorally, the area has a number of distinctive and important communities. Of particular note is that Ireland's only reported piddock bed thrives in the shallows of Aughinish Bay. The rare sponge, *Mycale contarenii*, is also found here. Of additional interest is the presence of an extensive maerl bed of *Phymatolithon calcareum* which occurs in the strong tidal currents of Muckinish Bay. There is also maerl off Finavarra Point and in Kinvarra Bay (*Lithothamnion corallioides*, *Lithophyllum dentatum* and *Lithophyllum fasciculatum*). An oyster bed in Kinvarra Bay and seagrass (*Zostera* spp.) beds off Finavarra Point are also important features.

Salt marshes are frequent within this extensive coastal site, with the best examples located east of a line running between Galway City and Kinvarra. In this area the coastline is highly indented, thus providing the sheltered conditions necessary for extensive salt marsh development. Common salt marsh species present include Thrift (*Armeria maritima*), Red Fescue (*Festuca rubra*), Common Scurvygrass (*Cochlearia officinalis*), Lax-flowered Sea-lavender (*Limonium humile*), Common Saltmarsh-grass (*Puccinellia maritima*), Saltmarsh Rush (*Juncus gerardi*) and Sea Rush (*Juncus maritimus*). On the lower levels of the salt marshes and within pans is found Glasswort (*Salicornia europaea* agg.). Shingle and stony beaches occur throughout the site, with the best examples found along the more exposed shores to the south and west of Galway City and to the north and east of Finnavara. In general, these shingle shorelines are sparsely vegetated, with such species as Curled Dock (*Rumex crispus*), Common Couch (*Elymus repens*), Sea Sandwort (*Honkenya peploides*) and Sea Beet (*Beta vulgaris*).

Galway Bay is one of the most important ornithological sites in the western region. It supports an excellent diversity of wintering wetland birds, with divers, grebes, cormorants, dabbling duck, sea duck and waders all well represented. There are internationally important wintering populations of Great Northern Diver (83) and Brent Goose (676), and nationally important populations of an additional sixteen species, i.e. Black-throated Diver (25), Cormorant (266), Mute Swan (150), Wigeon (1,157), Teal (690), Shoveler (88), Red-breasted Merganser (249), Ringed Plover (335), Golden Plover (2,030), Lapwing (3,969), Dunlin (2,149), Bar-tailed Godwit (447), Curlew (697), Redshank (505), Greenshank (20) and Turnstone (182) – all figures are average peaks for the 5 seasons 1995/96-1999/00. Of note is that the populations of Red-breasted Merganser and Ringed Plover represent 6.7% and 3.3% of the respective national totals. Black-throated Diver is a scarce species in Ireland and the Galway Bay population is the most regular in the country. Other species which occur in notable numbers include Little Grebe (35), Grey Heron (102), Long-tailed Duck (19) and Scaup (40). The bay is an important wintering site for gulls, especially Black-headed Gull (1,815), Common Gull (1,011) and Herring Gull (216). In addition, the following species also use the site: Red-throated Diver (13), Great Crested Grebe (16), Mallard (200), Shelduck (139), Common Scoter (79), Oystercatcher (575), Grey Plover (60), Black-tailed Godwit (45) and Great Black-backed Gull (124). The site provides both feeding and roost sites for most of the species, though some birds also commute to areas outside of the site. The wintering birds of Galway Bay have been monitored annually since 1980/81.

The site has several important populations of breeding birds, most notably colonies of Sandwich Tern (81 pairs in 1995) and Common Tern (99 pairs in 1995). A large Cormorant colony occurs on Deer Island – this had 205 pairs in 1985 and 300 pairs in 1989.

Inner Galway Bay provides good quality habitat for Common Seal, a species that is listed on Annex II of the E.U. Habitats Directive. In 1984, this seal colony was one of the top three sites in the country, with over 140 animals recorded. The seals use a range of haul-out sites distributed through the bay. The site provides optimum habitat for Otter.

While there are no imminent threats to the birds, a concern is that sewage effluent and detritus of the aquaculture industry could be deleterious to benthic communities and could affect food stocks of divers, seaduck and other birds. Bird populations may also be disturbed by aquaculture activities. Owing to the proximity of Galway City, shoreline habitats are under pressure from urban expansion and recreational activities.

This large coastal site is of immense ornithological importance, with two wintering species having populations of international importance and a further sixteen species having populations of national importance. The breeding colonies of Sandwich Tern, Common Tern and Cormorant are also of national importance. Also of note is that seven of the regularly occurring species are listed on Annex I of the E.U. Birds Directive, i.e. Red-throated Diver, Black-throated Diver, Great Northern Diver, Golden Plover, Bar-tailed Godwit, Sandwich Tern and Common Tern.

B2 Dunkellin and Aggard Stage 1 Bat Assessment

Table B2.1: Potential Value of the study area for Bats

Bridge	Potential Bat Use	Value	Comments
Kileely Bridge	Roosting, Foraging & Commuting	**High**	Kileely Bridge has a very high potential for bat usage. The underneath of the bridge is covered in Ivy which provides ideal feeding areas for bats. A visual inspection of the bridge crevices was also undertaken and scored a 2* (2 = crevices ideal for bats but no evidence of usage) The watercourse has continuous riparian vegetation which provides both foraging and commuting areas suitable for many bat species.
 Bridge Structure with Ivy underneath	 Suitable crevices		 Suitable crevices
Dunkellin Bridge	Foraging & Commuting	**Medium**	Provision of a new flood eye on the right bank could interfere with potential foraging area but no roost potential. The existing flood eyes have potential with a significant number of suitable crevices under all 3. There is potential for bats to forage and commute along the river edge in particular along the right bank downstream where tree removal is proposed. Large mature trees present with potential use as resting areas together with a low lying hedgerow which may be utilised for gleaning insects. A visual inspection of the bridge crevices was also undertaken and scored a 2* (2 = crevices ideal for bats but no evidence of usage)
 Bridge Structure Main Arch	 Right Bank – wing wall potential foraging area which could be impacted if flood eye is placed here.		 Additional flood eyes containing suitable crevices
Rinn Bridge	Foraging & Commuting	**Medium**	The current bridge structure has no potential underneath as a bat roost as it is a slab design. Foraging areas are present on both banks but with low value in the immediate vicinity of the bridge structure where works will take place. Farther up and down stream along both banks mature trees are present which provide potential foraging and commuting potential. These tress may have roosting potential and should be subjected to

Bridge	Potential Bat Use	Value	Comments
			a full survey if they are to be removed.
 Bridge Structure	 Bankside vegetation where additional flood eye will be placed		 Foraging and commuting route along watercourse
Railway Bridge	Foraging & commuting	**Medium**	While the proposed works will not cause a direct impact to the bridge structure the proposed works will impact on the riparian zone which has suitable foraging areas available to bats which would be lost if removed. Full night time survey required to assess usage.
 Railway Bridge Structure	 Suitable foraging areas on right bank adjacent to bridge		 Underneath bridge structure no roost potential as all crevices are sealed.
Masonry Arch Pedestrian Bridge at Craughwell	Foraging, Commuting and Roosting	**High**	All 6 arches are currently suitable and contain suitable crevices for bat usage but no evidence was found (Grease stains, droppings or other evidence). A visual inspection of the bridge crevices was also undertaken and scored a 2* (2 = crevices ideal for bats but no evidence of usage) Potential foraging area downstream from bridge. Any structural work to this bridge could impact on bat species. Night time survey required to assess full usage.
			

Bridge	Potential Bat Use	Value	Comments
R446 Bridge (Old N6 Bridge at Craughwell)	Commuting	**Low**	No alteration of structure of bridge proposed. This bridge has low value for bat usage and most likely is only used as a commuting route or corridor to suitable foraging areas downstream and suitable roosting areas.
			
Removal of trees upstream of Kilcolgan	**Foraging, commuting and potential roosting**	**High**	The existing tree line nearest the river has low potential for roosting as it contains young Ash, Blackthorn & Hazel trees. While it is extremely difficult to survey trees and be certain that any bat roosts have been detected together with the fact that many species are known to move unpredictably this font tree line appears to have low potential value from a day time activity survey. Whilst the front tree line may have low potential for roosting it has high potential as both a foraging and commuting route and any removal of trees could have a negative impact. The impact will depend how many trees are to be removed and how far back into the current woodland. A night time activity survey is required to assess the bat usage.
 Tree ling along front edge of river	 Young Ash trees to the front of the woodland		 Tree line along front edge of river

* Billington & Norman Grading

B3 OPW Arterial Drainage Environmental Management Protocols & Standard Operating Procedures

The Office of Public Works

Arterial Drainage Maintenance Service

Environmental Management Protocols

&

Standard Operating Procedures

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The Office of Public Works
Arterial Drainage Maintenance
Environmental Management Protocols & Standard Operating Procedures

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ENVIRONMENTAL MANAGEMENT PROTOCOLS

ARTERIAL DRAINAGE MAINTENANCE SERVICE
(APPLICABLE TO ENGINEERS, TECHNICIANS AND FOREMEN)

PART I – OPERATIONS MANAGEMENT

COMMUNICATIONS - STATUTORY STAKEHOLDERS

- By the end of September of each year, each Drainage Region to forward a ***draft*** copy if its Annual Works Programme for the coming year to OPW's Environment Section, and to the Inland Fisheries Ireland (IFI) EREP Project Manager who will review it for appropriate sites and study locations for the Environmental River Enhancement Programme 2008 -2012.
- By end of November of each year, each Drainage Region to forward the relevant sections of the Finalised Annual Maintenance Programme for the coming year with a copy of appropriate scheme maps, to the National Parks & Wildlife Services (NPWS) Regional Managers and the IFI Directors.
- When compiling the programme the type of works proposed should be indicated for each channel under the headings A-F to facilitate the Screening for Appropriate Assessment (AA).
  - A – Silt & Vegetation Management
  - B – Aquatic Vegetation Cutting
  - C – Bank Protection
  - D – Bush Cutting/Branch Trimming
  - E – Tree Cutting
  - F – Bridge/ Structure Repairs
- Ideally, approximate timing (season/month) and approximate duration of works should be included for each channel.
- Works that fall within SACs, SPAs or NHAs are to be highlighted on the programme.
- As a follow up, the Drainage Regions offer the opportunity for a meeting with the stakeholders to discuss the programme and where a meeting is requested, preferable for this to take place as early as possible in the year.
- Prior to entry onto a channel contained wholly or partly within an SAC, SPA or NHA, three weeks notice in advance of entry, and for SAC & SPA an AA Screening Statement/Conclusion Statement must be completed and forwarded through the NPWS District Conservation Officer.

INTERIM STAKEHOLDERS MEETINGS

- In addition to the start of the year stakeholder meeting to overview the Annual Works Programme, Regional Offices will offer and facilitate a schedule of more frequent and catchment focused meetings.
- The need and the frequency of these meetings will be determined on a regional basis in partnership with the relevant stakeholders.
- Typically a frequency of every 2-3 months to discuss the following 2-3 months work on the catchment, identifying any further environmental sensitivities, appropriate mitigating measures, follow up joint site visits where deemed beneficial and flagging any opportunities for added benefit in proposed River Enhancement works.
- Typical attendance includes a range of OPW Management Staff, i.e. Engineer, Technician and/or Foreman, NPWS Rangers and/or DCO and IFI Officers.
- OPW Engineer will compile minutes of the meeting to record attendance and a brief account

of main decisions and follow up actions.

- Any channel specific information resulting from these meetings, such as timing requests should be entered into the Records Database in accordance with the National Recording Process.
- Fruitful consultations with statutory stakeholders such as NPWS and IFI are of critical importance to continuously improving environmental performance. However, in the interest of maximising the efficiency of stakeholders input, Management Staff are as far as practical, to plan their consultative requirements and address a range of aspects in any one discussion forum. Interim Stakeholder Meetings or similar forums offer good opportunities to maximise consultation efficiencies.

CORRESPONDENCE

- All Environment related correspondence/complaints should be logged on the Engineering Services Correspondence Database as per normal protocol. Complaints received should be forwarded to the Environment Section should assistance be required.

WALKOVER SURVEYS

- As a component to the EREP Project, on a number of channels, EREP team will request for Walkover Surveys as an opportunity to discuss in detail on site the environmental options for a particular channel with a range of relevant stakeholders.
- Typical attendance will be an IFI EREP representative, a range of OPW Management Staff and relevant Operational Crew if deemed beneficial, local IFI Officer and/or NPWS Ranger or DCO.
- OPW Management Staff to liaise with EREP team and coordinate the site visit with local IFI and NPWS to facilitate their participation if these stakeholders wish to attend.
- Environmental procedures as agreed on-site will be recorded by IFI EREP team and issued to the OPW Engineer as part of the design guidance for the particular Enhanced Maintenance works.
- Regional Management Staff to ensure that Operational Staff carry out the works in accordance with the agreed procedures.

NATURA 2000 SITE ASSESSMENTS

- All scheduled maintenance operations in the vicinity of a Natura 2000 Site i.e. an SAC or SPA, will require Screening for Appropriate Assessment and Stage II Appropriate Assessment where required.
- By the end of September of each year, each Drainage Region to forward a ***draft*** copy if its Annual Works Programme for the coming year to OPW's Environment Section to facilitate this process.
- Environment Section will procure the Ecological Consultant, collate all the channel lists and issue completed AA Screening Statements/Conclusion Statements to the respective OPW engineers as completed.
- The Ecological Consultant will consult with OPW management to define the precise extents of proposed works in each Natura 2000 Site.
- In addition, the Ecological Consultant will be carrying out walkover surveys for pre and post maintenance works for a representative number of the sites and OPW Management will be required to facilitate the same.
- OPW Management Staff will issue the relevant completed Assessments directly to the NPWS District Conservation Officer.In addition, Environment Section will issue all of the Assessments to the Development Applications Unit, DEHLG, Dun Sceine, Harcourt Lane,

Dublin 2.

- Preferably for the Assessments to be forwarded to the DCO as soon as it is completed, but in any case with a minimum of three weeks notice before commencement of the works.
- Management Staff to implement all prescribed mitigating measures and ensure that Operational Staff are made aware of all relevant site specific mitigating measures.

Current version of Designated Sites GIS Layers available on Socialtext

Environmental River Enhancement Programme (EREP)

- After reviewing the draft Annual Works Programme, IFI EREP team will revert to the respective Regional Engineers Office and request follow up meetings as required to discuss aspects of the programme in relation to the EREP.
- Enhancement sites require ground truthing to ensure they are technically feasible as envisaged. This is to be coordinated by the IFI EREP team with local IFI and OPW personnel as required.
- Sites shortlisted by IFI EREP team for Capital Enhancement works are emanating from a screening process of technical feasibility in terms of gradient and water quality. In the future, sites selected will increasingly be resulting from other requirements such as the Water Framework Directive Programme Of Measures under Morphology.
- IFI EREP team in consultation with the local IFI and OPW, will prioritise sites on a basis of best return for investment. IFI EREP team will liaise with the Regional Offices to assist in identifying channels deemed suitable for capital enhancement which should be integrated with the following years work programme. In some cases, a situation may arise where the site selected is not overlapping with the current Annual Works Programme but where feasible and subject to any third party agreement, OPW will accommodate these works.
- Similarly for enhanced maintenance works, IFI EREP team in consultation with the local IFI and OPW, will select sites again that are technically feasible and offer best return for investment. These sites will normally be from channels on the current Annual Works Programme.
- IFI EREP team will coordinate all the scientific monitoring works, provide the enhancement design details and guidance to OPW Management Staff and maintain a reasonable level of site supervision, proportional to the complexity of the works and the experience of the OPW Staff involved.
- Consultations with local IFI through the Interim Stakeholder meetings are encouraged to identify sites suitable for Enhancement works and in some cases the local IFI may also be in a position to produce an enhancement design. All enhancement designs and works are to be coordinated through the IFI EREP team to facilitate formal recording into the national EREP project and allow for biodiversity and/or hydromorphology monitoring if required. Local IFI may coordinate with IFI EREP team or alternatively OPW Regional Staff coordinate directly with the EREP team.
- A small portion of channels have more infrequent maintenance cycles and these cases can offer particularly good opportunities for enhanced maintenance type works. Channels programmed where maintenance works have not being carried out for in excess of 10 years, to be flagged to IFI EREP team for possible Walkover Surveys and guidance on appropriate EDM procedures.
- Management Staff to ensure that as far as practical, all Operational crews have an opportunity to get experience on these projects.

- Each Regional Engineer is to make provision in the Annual Works Programme for Plant & Labour resources in addition to provisions in the Annual Budget for materials subject to expenditure constraints. Typical resources are as follows:

Capital Enhancement

Region	Target (Km)	Capital Costs	Machine Weeks	ManWeeks
East Region	20	€200,000	30	60
South West Region	14	€140,000	21	42
West Region	16	€160,000	24	48
	50	**€500,000**	**75**	**150**

Enhanced Maintenance *(in conjunction with routine maintenance)*

Region	Target (Km)	Capital Costs	Machine Weeks	ManWeeks
East Region	20		15	0
South West Region	14		11	0
West Region	16		12	0
	50		**38**	**0**

- Progress targets for EREP to be shown on monthly production reports.
- OPW are the primary contact point for liaison with landowners including the organising of access and egress for machinery and materials. Brochures on EREP are available in all Regional Offices. Additional copies can be obtained through OPW Environment Section.
- Management Staff are encouraged to maximise the use of all available on-site materials such as stone from historical spoil heaps as opposed to importing materials at a higher cost.
- In addition, Management Staff are encouraged to maximise synergies with other funding sources such as Fisheries Development grants attained by local Angling Clubs which could combine with OPW plant and labour to supply materials.
- In all cases, Inland Fisheries Ireland are the statutory authority to give design guidance to OPW. Angling Clubs or other sectoral funding sources to liaise with the Fisheries authorities in respect of all design and environmental monitoring requirements.
- As-Built plans are to be completed by the IFI EREP team for all enhancement works. This will entail a site visit by IFI and relevant OPW Staff where requested. These will be retained by IFI as well as any relevant design information.
- IFI EREP team will forward a copy of the As-Built plans to Environment Section who will upload the same to Socialtext for access to the information by all Staff.
- At the end of the year, IFI EREP team will forward Environment Section a GIS layer of that year's works for uploading to OPWs GIS records.

Current version of Enhancement GIS Layer available on Socialtext

National Recording Process

- Weekly Record Cards can contain information on Lamprey, Crayfish, Kingfisher, Mussels, Otter and other site specific environmental information as arises.
- Environmental information on Cards will be recorded onto the Records Database by each Drainage office. The latest Records Database has been revised to integrate environmental records.
- On an interim basis, a copy of all Cards with environmental information to be copied and

forwarded to Environment Section by each Drainage Office. This is to allow Environment Section to review the detail of information being recorded, feedback to the Operational crews through the Management Staff and attain a national consistency in the style of information being recorded.

- All relevant information to be uploaded to GIS by Environment Section.
- All other relevant environmental information sourced by Management Staff whether from direct observations or through stakeholder consultations, should be entered into the Records Database.
- Relevant environmental information sourced through the EREP project and related research will be forwarded by IFI EREP team to Environment Section directly for centralised GIS uploading.
- On an annual basis, Environment Section will compile an update of Weekly Records Cards species records and make available to all Staff via Socialtext to assist in tracking progress.
- On an ongoing basis, Environment Section will make available the various OPW compiled species records to other authorities to assist in contributing to any appropriate national conservation knowledge.
- As described above, each drainage office will upload onto the Records Database all environmental information from the Weekly Record Cards and all other broader environmental information attained by Management Staff. Within a few years, it's envisaged that multiple regional Staff will be able to use the new Records Database, and then environmental information from all sources will be uploaded directly by a whole host of Staff. Typically this will include any mitigating agreements for particular channels agreed with stakeholders or any other individuals observation such as protected species presence noted during a separate site visit.

Salmonids

- As far as practicable, the maintenance works are to be scheduled to accommodate salmonid (Salmon & Trout) spawning areas, as is in place across all regions for many years. This is a widespread measure on many catchments and is most applicable to medium gradient channels with gravel substrate.
- Prior to works commencing, consult with local IFI. Ideally, consultations to be conducted through Interim Stakeholder Meetings or alternatively, direct contact in respect of the specific site.
- Maintenance operations on salmonid spawning beds typically carried out between July and September but timing subject to adjustment due to local knowledge of IFI.
- Raking of spawning gravels to improve spawning capacity also typically carried out between July and September.
- River enhancement works to enhance both the fisheries and the broader ecology of the drainage channel are covered under the EREP project.
- In the future, as the extent of completed enhancement works increases, there is a risk of damage to structures due to future maintenance. All channels scheduled for maintenance to be checked against GIS records for presence of previous enhancement works. Where a presence is indicated, carry out a site visit as appropriate and in consultation with IFI , devise on-site procedures to protect or enhance existing instream structures.

Current version of Enhancements & Spawning GIS Layers available on Socialtext.

Lamprey (Brook, River & Sea) & Crayfish

- All channels scheduled for maintenance to be checked against GIS records for presence of Lamprey or Crayfish.

- In accordance with the SOPs, Operational Staff will closely observe the spoil three times daily and report to the Foreman any Lamprey or Crayfish located.
- Mitigating procedures to apply when:
  - GIS records indicate species presence, or
  - Operational Staff locate Lamprey or Crayfish during operations, or
  - Where particularly suitable habitat is identified by an environmental stakeholder.
- If significant populations are encountered, notify IFI EREP team and facilitate scientific studies if site deemed suitable by IFI.
- If significant populations are encountered, notify NPWS Ranger and local IFI Officer and conduct site visit as necessary.
- Combination of Mitigating Measures to be selected as applicable to the site while balancing the Flood Risk Management requirements and a sustainable approach to the conservation of Lamprey and/or Crayfish.
- Identify extent of channel applicable and the mitigating measures to apply.
- Inform Operational Staff of mitigating requirements.

Suite of relevant Mitigating Measures as follows:

On site measures

- Skip sections to retain intact habitat either in one long reach or multiple short reaches.
- Maintenance in an upstream direction to avoid secondary disturbance of a species moving downstream. Balance with the advantage of maintenance in a downstream direction where instream vegetation minimises siltation.
- Confine maintenance to 2/3 of channel width leaving marginal vegetation and silt intact.
- Maximise use of weed cutting bucket particularly where aquatic vegetation removal is the primary objective. This is effective for Lamprey juveniles as they are in the silt. For Crayfish, cutting of "Flaggers" type vegetation is effective but cutting of "water celery" mat type vegetation is less effective as it can result in Crayfish being removed within the weed mass.

Forward planning measures

- Annual maintenance of the channel in shorter segments sequentially completing the same over a number of years. Balance with maintaining reasonably operational efficiency in terms of machinery moving, transport, access and egress.
- Longer time periods between maintenance cycles e.g. move from 4-6 years to 7 to 8 years. Balance with overall river ecology as longer maintenance cycles will lead to more heavy-scale works.
- Timing of maintenance to accommodate Lamprey spawning. Stakeholder consultations between OPW and local IFI for salmomid mitigating purposes, to include consideration of Lamprey spawning. This is to be applied to channels where Lamprey spawning habitat is known as informed by IFI or other stakeholder. For River & Brook Lamprey, no works on relevant spawning channel from end March to start of June subject to adjustment due to local knowledge of IFI. For Sea Lamprey, as they spawn during the summer months, restrictions from late April to early July are required. To be applied to channels where Sea Lamprey spawning is known as informed by IFI or other stakeholder and timing subject to adjustment due to local knowledge of IFI. Note that Sea Lamprey are much less widespread so envisaged that the scale of this mitigation will be very limited.
- Loosening spawning bed gravels. Stakeholder consultations between OPW and IFI for salmonid gravel loosening purposes, now to include consideration of Lamprey spawning as above.
- Enhance channel profile such as skewed cross section and promote deposition of silt along margins. Integrate with IFI discussions on planning the EREP to avail of enhancement

opportunities particularly for channels where Lamprey or Crayfish presence is recorded.

- Modification of OPW structures which impede upstream migration. Identification of weirs as barriers to be as informed by IFI or other stakeholder. Where modification designs required, liaison with IFI EREP team to integrate the improvement works into the EREP project. Identification of a bridge apron step attained through ongoing site inspections by OPW Management Staff or other stakeholder. In consultation with IFI, steps at bridges to be modified by a rock armour type ramp or similar. Envisaged that these measures will be of a limited scale on drained channels.

GIS Records:

- Where Lamprey or Crayfish are discovered, Operational Staff will have recorded the same on the Weekly Record Cards. Cards with species location information will be uploaded to the Records Database as stated in the National Recording Process.
- All new Lamprey spawning location information attained through stakeholder consultation to be recorded on the Records Database in accordance with the National Recording Process.
- All database records of species location will be uploaded to GIS by Environment Section.
- IFI EREP team conducting ongoing research on Lamprey & Crayfish as a component of the EREP works. Scientific data calculating species density for some sites will be developed and to be supplied by IFI to OPW and uploaded to GIS by Environment Section.

Current version of relevant SOPs: *V2 April 2009*
Current version of relevant GIS Layers available on Socialtext.

Otter

- Research to date indicates that Otters are widespread across all sizes of drainage channels nationally, hence it is prudent to assume that Otter use any particular site.
- In accordance with the Otter SOP, Operational Staff will walkover the works area one week in advance in conjunction with the Health & Safety assessment noting dense cover with access directly to the water that is to be avoided where feasible.
- In addition, any recognisable signs of Otter presence observed such as Spraints, Footprints or suspected Holts, will be recorded on the Weekly Record Cards. These signs were identified in Otter Awareness Training carried out across all regions in 2008.
- While holts are usually well concealed, where Operational Staff observe a suspected holt such as a burrow opening, in consultation with Management Staff, subject to flood risk management functions, no works to within a 50m buffer each side.

Bridge mammal crossing enhancement

- As a component of ongoing consultations with NPWS and other stakeholders, evidence may arise from time to time as to a particular spot for Otter road kill. Typically this can arise where the Otter always traverses the roadway as opposed to going through the bridge. While this scenario is not known to be a widespread issue in Ireland, the highest risk locations are on the National Primary Roads which have the heaviest traffic volumes.
- There are 170 National Primary Road bridges on OPW channels as listed in the table referenced below and Management Staff are to have particular regard to these locations if evidence arises on a possible road kill "hot spot".
- Enhancement works will typically take the form of a bolt-on wildlife ledge or similar. Design and configuration is to carried out in consultation with NPWS and relevant Local Authority.
- On an annual basis, Environment Section will review the national website www.biology.ie which records Otter road kill reports from the public. Any road kill location which overlaps with an OPW channel will be flagged by Environment Section to the relevant Management

Staff.

- Current understanding is that Otter road kill is not a significant issue in Ireland. It's envisaged that while the justification for bridge mammal crossing works may arise for some scenarios, these measures will be of a limited scale on drained channels.

Current version of Otter SOP: V2 April 2009
Current version of National Primary Roads & OPW Bridges: March 2009

Freshwater Pearl Mussel

- GIS records from NPWS show the locations of the 91 known FWPM populations in Ireland.
- The following OPW channels have been identified as containing FWPM:

Channel	Scheme	Location	Most Recent Record
CH9	Corrib Headford	Oughterard	2009
C1/21/3	Moy	Approx 500yrds from outfall to into L. Cullin	2004
C1 Sect M&N	Moy	Ballygallagart	2004
C1/21/14	Moy	Crossmolina	2008
C1	Dunmanway FRS	d/s of the Long Bridge	2003
C1	Owvane	Approx 1400 yrds from outfall	2002
C1	Feale	d/s Listowel near Scartleigh cemetary	2006
**Owenaher	Moy	u/s of C1/54	1996
**Brown Flesk River	Maine	Trib of C1 Maine near Farranfore	1987
** Galey River	Feale	Approx 1400yrds u/s of C1/18 near Ahavoher Br.	1950
**River Liffey	Ryewater	(Lucan) Approx 3.5km d/s C1 Ryewater outfall	1894

** Although not on OPW channels - these channels may or may not contain populations of FWPM. Works in the vicinity which could impact on a possible population need to be considered in close consultation with local NPWS knowledge.

- While highly unlikely to have instream works in a FWPM habitat, if a new population located by Operational Staff during operations, works to cease.
- Notify NPWS and in consultation with NPWS, area to be skipped or non in-stream works carried out as agreed for the specific site.
- For operations in the vicinity of known populations, mitigating procedures to apply:
- Consult with NPWS and local IFI and conduct site visit as necessary.
  - Typically only selective non in-stream works adjoining the population.
  - Works such as removal of a fallen tree is to be completed by lifting clear of the channel to minimise any channel bed disturbance due to the branches being dragged.
  - Assess need for silt management procedures for works upstream of the population and implement in consultation with NPWS.

Current version of relevant SOPs: V2 April 2009
Current version of FWPM GIS Layer available on Socialtext.

Swan & Duck Mussels

- Swan and Duck Mussels are not strictly a protected species, however they are of conservation interest.
- Both species are similar in appearance and habitat requirements and distinguishing between them is not necessary unless local environmental stakeholders can identify the exact species.

- As the Mussel SOP, if Operational Staff locate the same, Management Staff will be notified.
- Where significant populations are encountered notify NPWS Ranger and local IFI Officer, and where they are interested in visiting the site, facilitate a site visit as necessary.
- Identify extent of channel applicable and the mitigating measures to apply.
- Typical Mitigating Measures include:
  - Operational Staff to observe spoil and return any Mussels to the channel whom are expected to recolonise the channel bed.
  - Maximise use of weed cutting bucket particularly where aquatic vegetation removal is the primary objective.
  - Skip sections to retain intact habitat either in one long reach or multiple short reaches.
  - Confine maintenance to 2/3 of channel width leaving marginal vegetation and silt intact.
- Record species presence on the Weekly Record Cards which will be recorded on the Records Database.

Current version of relevant SOPs: V2 April 2009

KINGFISHER

- Avoid disturbing nesting sites in banks.
- Visual sightings of Kingfisher by Operational Staff to be recorded on the Weekly Record Cards.
- Sightings by Management Staff to be recorded on the Weekly Record Cards where works in progress or on other occasions, record by separate map or channel reference format.
- All sightings to be recorded on the Records Database in accordance with the National Recording Process.
- All database records of species location will be uploaded to GIS by Environment Section.
- On an annual basis, Environment Section will issue the records to Birdwatch Ireland whom will add to the national Kingfisher database.

Current version of Kingfisher GIS Layer available on Socialtext.

BIRDS

- Removal of any abnormally dense layer of vegetation is to be executed between September and February (inclusive) to minimise impacts on nesting birds unless there are other overriding requirements such as Health & Safety.
- For SPAs containing important over-wintering bird populations, in consultation with the NPWS, regard to be given to timing or phasing of the works to minimise potential disturbance.

BATS

- While the removal of large mature trees is not typically a requirement of maintenance works, where the case arises, in consultation with NPWS, regard to be given to the likelihood of bat roosting habitat.
- Typical mitigating measure would be to leave tree in fallen position for 24hrs to allow any bats vacate.
- Masonry bridges offer niches and crevices suitable for bat roosts and where masonry bridges are scheduled for maintenance works, regard to be given to the likelihood of bat roosting habitat. Typical maintenance works at low level such as wing wall repair or underpinning foundations have limited potential to impact on bat roosts. Where the case arises that repair works are to be above the high water level such as the upper arch, in consultation with

NPWS, assess the potential for the works impacting on bat roosts.
- Typical mitigating measure would be to contract a bat specialist to survey for bat presence before works commence, to avoid entombment of any bats.

WETLANDS - BOGS, FENS & TURLOUGHS

- All channels scheduled for maintenance which overlap SAC designations to be checked against the list of channels that impinge on Raised Bog, Fen habitat or Turloughs and have regard to any NPWS agreements noted *.
- OPW Management Staff to consult with NPWS for expert opinion as to any evidence of ongoing ecological decline of the Bog, Fen or Turlough and judgement on, if the drainage datum set by the Drainage Scheme and its maintenance is an ongoing contributing factor by affecting the hydrological regime of the same.
- Where a likely impact is identified, conduct site visit as necessary and in consultation with NPWS, mitigating measures to be selected such as:
- Skipping the channel in question while taking cognisance of the flood risk management requirements.
- Maximise use of weed cutting bucket particularly where aquatic vegetation removal is the primary objective.
- Inspection by OPW line management to assess the possibility of over digging the channel below the original design datum. Presence of an existing water level control such as a bridge floor to be established and alternative reference datum to be installed if deemed warranted.

** Environment Section currently developing a list of channels which overlap with Raised Bog, Fen habitat and Turloughs within SACs. Channels that are subject to a previous NPWS agreement /understanding of the extent of maintenance will be recorded.*

Current version of Wetlands channels list available on Socialtext.

INVASIVE SPECIES – PLANTS

- Multiple invasive plant species are widespread nationally as described in the SOP and prudent to assume that one or more of these plants can be present on any works site.
- At present the OPW does not have any direct responsibility for the management of Invasive species. However to ensure OPW operations are not a vector for these invasives, measures are required to reduce the risk of spread.
- Ensure machine washing equipment transported to site for all appropriate machinery movements as described in the Invasive Species SOP.
- Ongoing EDM site audits by Environment Section will include confirmation that machine washing was executed in accordance with the SOP for the last applicable machine transfer.
- In some cases, OPW will assist other authorities in the control of invasive species. In these projects, the works are typically carried out in partnership between a number of authorities such as IFI, NPWS and relevant Local Authority. As scenarios arise where OPW are requested to assist in an invasive species control project, Management Staff are encouraged to support the multi-authority partnership model which will maximise resource efficiencies for all parties while still achieving a broader environmental good.

Current version of relevant SOP: *V2 March 2009*

INVASIVE SPECIES – ZEBRA MUSSEL

- Zebra Mussels are present in the River Shannon, Grand Canal and are in many lakes such as

L Derg, L Ree, L Garra, L Key, L Derragh, Derravaragh, L Sheelin and L Corrib. This species is spreading and it is prudent to assume that works in any large sluggish river or near a lake has potential to contain Zebra Mussel.
- For any proposed works in the vicinity of potential Zebra Mussel waters, flag for Operational Staff and ensure particular attention to cleaning procedures for all equipment prior to removal from site.
- Any new location of Zebra Mussel uncovered during operations, notify NPWS and IFI for their information.
- Record on Weekly Record Sheet which will be uploaded on the Records Database in accordance with the National Recording Process.
- On an annual basis, Environment Section will collate the records nationally and issue to any relevant authorities to assist in tracking the species spread.

Current version of relevant SOP: *V2 May 2009*

Tree Management

- A small portion of channels have more infrequent maintenance cycles typically where self cleaning gradients are present. These sites can entail abnormally dense tree cover which may be required to be managed for conveyance or fisheries purposes. Removal of any abnormally dense layer of vegetation is to be executed between September and February (inclusive) to minimise impacts on nesting birds unless there are other overriding requirements.
- IFI requests to reduce "tunnelling" on drainage channels to be accomodated where feasible. OPW Management Staff to facilitate a site visit with the IFI Officer as required and devise a selective approach to the tree removal so as to retain a dappling of shade along the channel length.
- Excess woody vegetation to be collected and utilised by the following in order of preference:
  - Reused by adjoining landowner for domestic firewood.
  - Subject to landowners agreement, stockpile excess to form natural cover and niche habitat, preferably with some connection of cover to the channel e.g. along a hedge leading to the water.
  - Shred and spread along the adjoining top of bank allowing the material to degrade rapidly and recolonisation of the underlying vegetation.

Environmental Drainage Maintenance (EDM) Guidelines

- A portion of operational crews will be audited annually for implementation of the EDM Guidelines and other standard environmental procedures as adopted.
- Auditing will be carried out separately by both IFI and OPW Environment Section on a rotational basis to ensure all operational crews are audited at least once every three years.
- Audit results will be recorded on a standard format with the following feedback:
  - All audit results will be forwarded to the relevant Engineer for that Drainage Scheme within two working weeks.
  - In the event of an audit showing elements of unreasonable non-compliance with procedures, the relevant Engineer will be notified within one working day.
  - Audit results will be forwarded to OPW Systems Co-ordinator for inclusion in monthly regional benchmarking reports.
  - IFI EREP team will compile an overall summary of their findings in their end of year report under the EREP project.
- Design for Enhanced Maintenance works under EREP will include a design element for full

scale implementation of the EDM Guidelines such as Boulder Replacement and Excavating Pools.

- Management Staff to ensure that as far as practical, all Operational crews have an opportunity to get experience on these projects.

Current version of EDM Guidelines: April 2011
Current version EDM Audit Sheet: April 2011

PART II – DEPOT MANAGEMENT

Depot Waste Management

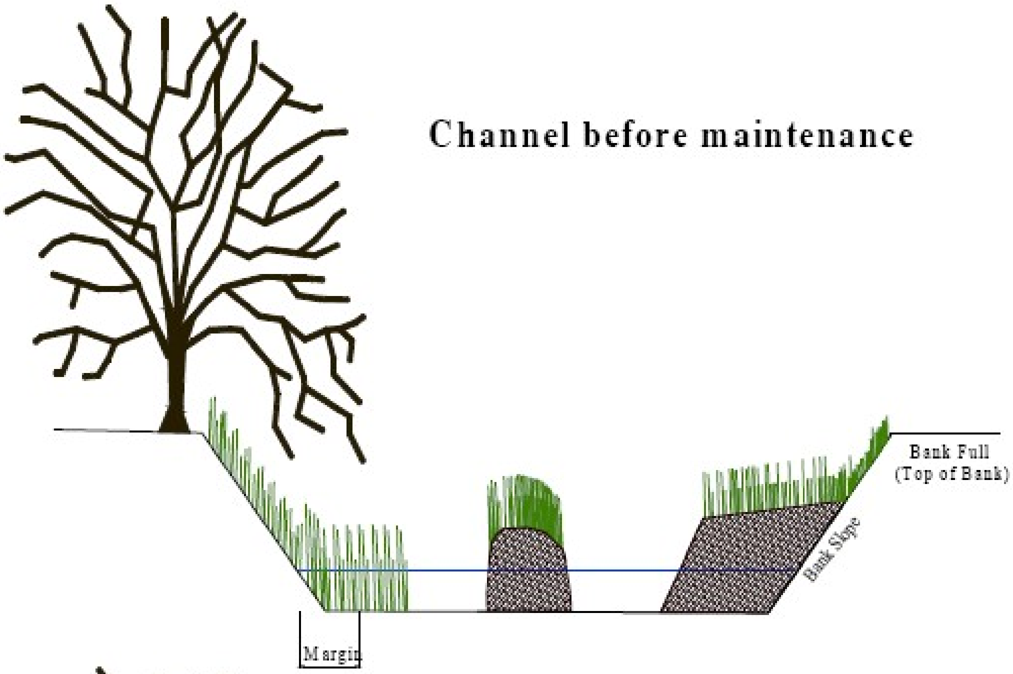
- 12 Waste Management Plans are available on Socialtext covering the 12 Drainage Offices.
- Environment Section will review 2 plans per annum and audit implementation.
- Updated Plans together with an overview of findings will be forwarded to the relevant Coordinator and uploaded to Socialtext.

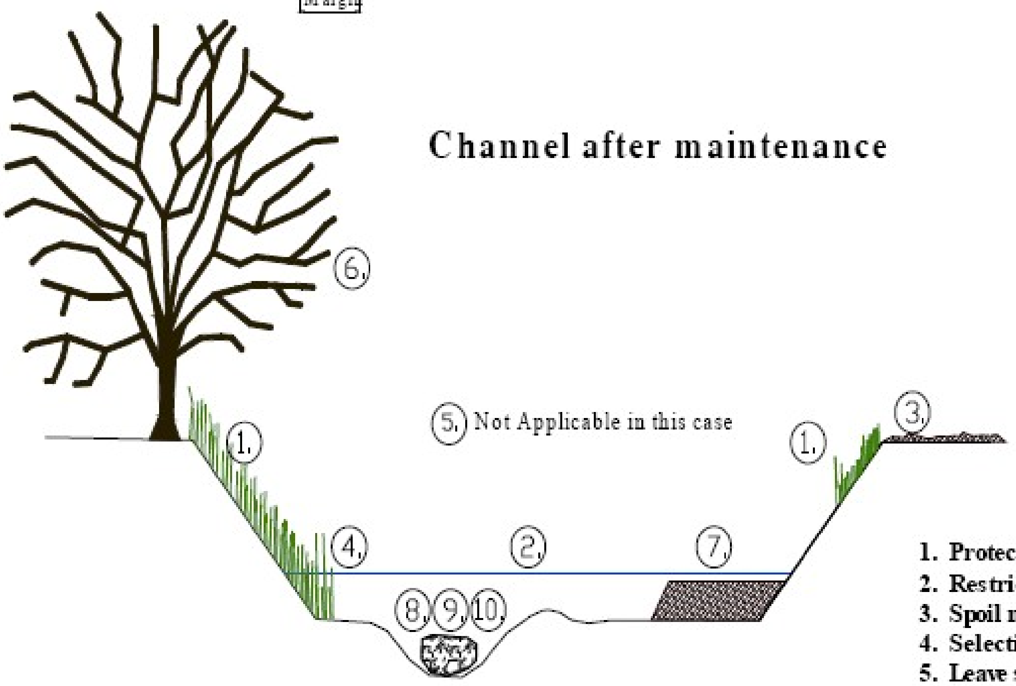
Future Revisions

- Envisaged that this set of Protocols will be a fluid document and will be periodically updated as procedures are revised or new procedures introduced. In addition, to be used as a framework document for quality control purposes to reference the latest versions of all supporting information.

Environmental Drainage Maintenance
Guidance Notes

10 Steps to
Environmentally Friendly Maintenance





1. Protect bank slopes
2. Restrict maintenance to channel
3. Spoil management
4. Selective vegetation removal
5. Leave section untouched
6. Management of trees
7. Manage berm to form two stage channel
8. Replace stones and boulders
9. Loosen gravel beds
10. Re-profile channel bed

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Inland Fisheries Ireland

April 2011

Environmental Strategies for Channel Maintenance

OPW

1. Protect bank slopes

1.1 Do not disturb the non-working bank slope

1.2 Minimise any effect on working bank

1.3 Leave margin of vegetation at foot of each bank slope

2. Restrict maintenance to channel

2.1 Remove only necessary silt – **<u>no new diggings</u>**

2.2 Remove instream material only

2.3 Retain marginal vegetation

2.4 Check spoil regularly. ***See Lamprey & Crayfish SOPs***

3. Spoil Management

3.1 Maximise spoil placement on bank full line or spoil heaps
and

3.2 Minimise spoil placement on bank slopes

3.3 Spread spoil as thinly as possible

3.4 Allow water to drain out of bucket over the water – lets small fish, lamprey and crayfish escape

Iascach Intíre Éireann
Inland Fisheries Ireland

April 2011

4. Selective Vegetation Removal

4.1 Retain a band of vegetation on both sides at water's edge

4.2 Selectively manage instream vegetation

4.3 Maximise use of weed-cutting bucket

4.4 Avoid maintenance in coarse fish channels from 1st April to 1st July

4.5 Retain 1/3 to ½ of instream floating type vegetation, such as *Ranunculus* (water crowfoot) – see photo to right

5. Leave sections untouched

5.1 If channel capacity is not affected, leave section alone

6. Management of Trees

6.1 Remove trees that are blocking the flow

6.2 Tree-cutting window 1st September to 28th February

6.3 Remove overhanging branches to known flood level

6.4 Use saw secateurs for removal, not excavator bucket

6.5 Manage Trees to reduce very heavy shading

6.6 Manage briars and scrub.
See Otter SOP

7. Manage berms to form two-stage channels

7.1 Retain berm where channel capacity is not affected

7.2 Remove top of berms to low flow levels

7.2 Remove vegetation and soil from gravel berms

7.3 Replace sod to the berm where feasible

7.4 Only narrow berms if 'excessively' wide for the channel (i.e. greater than a third of the channel width

8. Replace stone and boulders

8.1 Reinstate boulders and gravels as removed by maintenance operations

8.2 Reinstate suitably sized boulders into channel from spoil heaps where feasible

8.3 Boulders should be placed at or below low flow level and spaced out

9. Work in gravel bed channels

9.1 Loosen or toss bed gravels to wash out fines

9.2 Only considered between 1st July and 30th September

9.3 No work in gravel bed / spawning channels in fisheries 'closed season' *Note:* This varies locally check with local IFI

10.1 Excavate bed to form deeper pool areas and shallow riffles

10.2 Overdeepen the channel along one side and place spoil on opposite side –particularly on curves and bends

10.3 Use existing boulders to form **simple** low-level structures

10.4 Record where such works are carried out

Actions during Maintenance Operations

- Machine gangs to closely observe the spoil three times daily for Lamprey (and Crayfish).
- Where Lamprey encountered:
  - Contact area Foreman immediately.
  - Foreman to contact Engineering Staff in line with the Environmental Management Protocols.
  - Record the location and abundance of Lamprey on the time card.

Measures as directed by Foreman to minimise impact may include:

- Skip a defined stretch of channel.
- Confine maintenance to 2/3 of channel width leaving marginal vegetation and silt intact.
- Maximise use of weed cutting bucket particularly where aquatic vegetation removal is the primary objective.

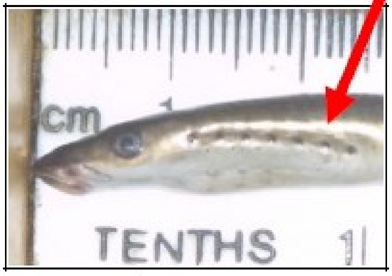
Lamprey in the spoil

OPW

RIVER, BROOK & SEA LAMPREY IDENTIFICATION CARD

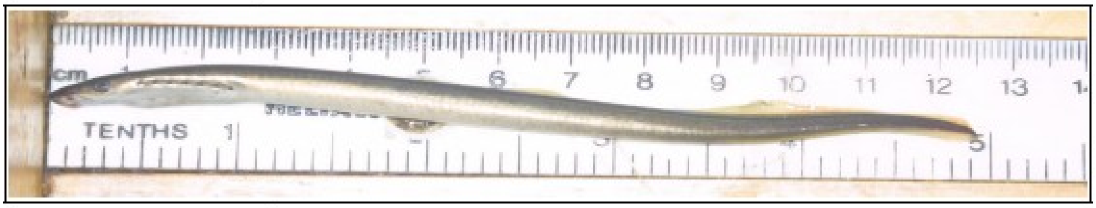
Lamprey and young eels can look very similar. These key identifying features can be used to distinguish the two species

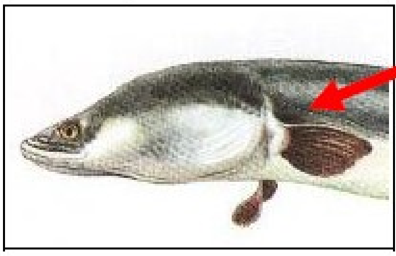
Gill Pores



Lamprey:

- Gill Pores (Holes)
- No Fins
- No Jaw
- Average length 8 to 15cm (3 to 6 inches)





No Gill pores

Eels: No Gill Pores

Paired Fins

Jawed Mouth

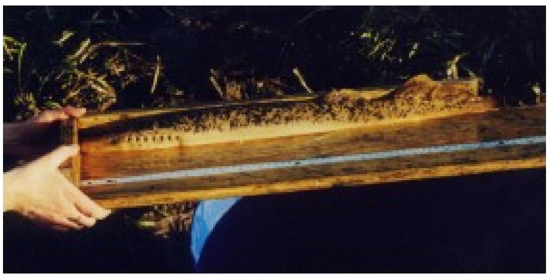
Average length 65cm (26 inches)

Juvenile Lamprey:

- Juvenile Lampreys live in the sediment.
- It is in this juvenile phase that they can be removed from the sediment during maintenance.

Adult Lamprey:

- Largest is the Sea Lamprey species.
- Also are River and Brook Lamprey
- Length from 30 to 60cm (12 to 24 inches).



Actions during Maintenance Operations

- Machine gangs to closely observe the spoil three times daily for Crayfish (and Lamprey).
- Where Crayfish encountered:
  - Contact area Foreman immediately.
  - Foreman to contact Engineering Staff in line with the Environmental Management Protocols.
  - Record the location and abundance of Crayfish on the time card.

Measures as directed by Foreman to minimise impact may include:

- Skip a defined stretch of channel.
- Confine maintenance to 2/3 of channel width leaving marginal vegetation and silt intact.
- Maximise use of weed cutting bucket particularly where aquatic vegetation removal is the primary objective.

Crayfish in the spoil

Identification

- Resemble small lobsters.
- Colour varies from light to dark green-brown, with large front claws.
- Adults typically 7cm - 10cm (3" - 4") long.
- Juveniles can be a small as 2cm (1") long.
- Prefer channels with
  - dense weed cover (flaggers / watercelery) or
  - with a mixture of rocks / gravels that provide crevices for cover.

Week before Maintenance Operations begin:

- Operational staff will walkover works area one week in advance in conjunction with the PRA noting areas of dense cover with access directly to the water. (As identified during Otter Awareness Training)
- These areas of suitable cover should be avoided where feasible during maintenance.
- Suspected presence of an Otter holt to be reported immediately to area Foreman, who will contact Engineering Staff in line with the Environmental Management Protocols.
- Signs of Otter presence observed such as Spraints, Footprints or suspected Holts, to be recorded on the Weekly Record Cards.

Measures to minimise disturbance may include:

- Retain suitable cover where possible.
- Areas of dense scrub to be avoided by large plant.
- Skip stretch of channel in proximity of suspected holt.

Otters

- Widespread presence on OPW channels.
- Shy animals and not normally seen.
- Adults 1 metre long and weigh 10kg.
- Streamlined profile.

OTTER

Holts

- Usually well concealed.
- Typically burrows, or spaces under banks, tree roots or dense cover.

Spraints

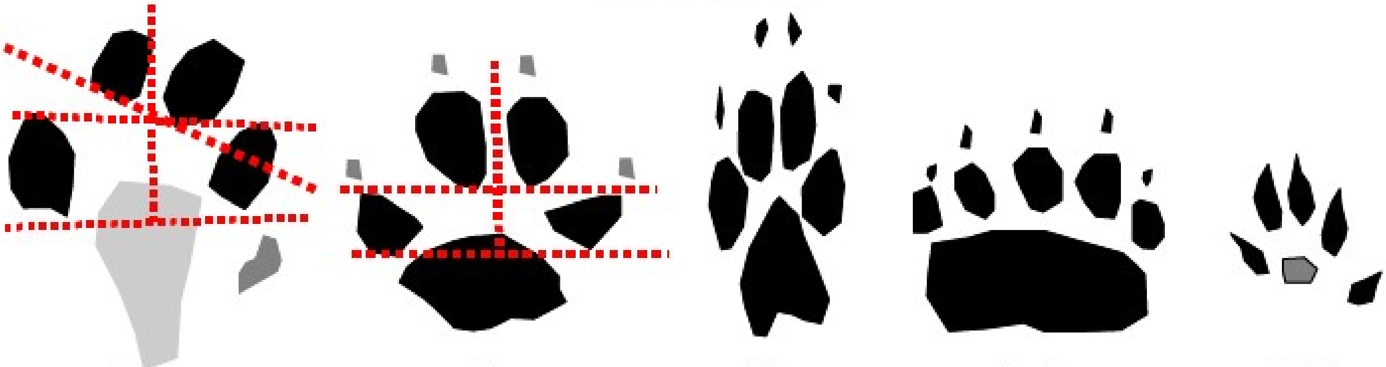
- Found on rocks, paths, channel junctions.
- Dark, oily, sweet smelling.

Suitable areas of cover

Dense bankside vegetation, particularly where there is direct covered access to the water.

Any isolated clumps of dense vegetation giving cover along an open length of channel.

Foot-prints



Otter (Non-symmetrical toes) | **Dog** (Symmetrical toes) | **Fox** | **Badger** | **Mink**

FRESH WATER PEARL MUSSELS

Before Maintenance Operations begin:

- Maintenance must not commence where a known population of Fresh Water Pearl Mussel exists (as listed in the Environmental Management Protocols).

- In the unlikely event of new population of Fresh Water Pearl Mussel being encountered during maintenance,
  - **All works must cease immediately.**
  - Contact area Foreman.
  - Record the location of Mussels on the time card.

Measures to minimise disturbance may include:

- Placing of straw bales to prevent movement of silt.
- Any exceptional / emergency works to be carried out in close consultation with the NPWS.
- For exceptional / emergency works e.g. fallen tree obstruction – these to be lifted clear of the channel to prevent disturbing the channel bed.

Fresh Water Pearl Mussels *(Margaritifera margaritifera)*

- Shells very thick & heavy – shaped like a kidney.
- Shell colour is dark-brown – black, to blue & black.
- Adults range in length from approx. 6 cm – 12 cm (2.5 – 5 inches) and can live for over 100 years.
- Suitable rivers are reasonably fast flowing, with very clean, good quality water, gravel bed, preferably with large cobbles.

Not to be confused with Duck & Swan Mussel

- Egg-shaped shells 12 -16cm (5-6 inches) long.
- Thin shiny shells, usually brownish yellow with traces of green.
- Found in slow moving water.
- If encountered, contact area Foreman and return Mussels to channel.
- Record location of Mussels on time card

Measures to reduce the risk of spread of invasive species

All excavators, weed cutting boats, tractors, dumpers & other machinery employed on maintenance must be thoroughly cleaned down using a power washer unit prior to being;

(a) transported by Low- Loader

(b) moving to another catchment within the Region

(c) moving to another Region.

Notify your supervisor immediately if you see any of the invasive species listed.

Full details of all species are available in the CFB's Field guide to the Identification of Aquatic Invasive Species

Giant Hogweed

Found on the banks of many rivers througho Ireland.
Can grow to a height of 4 metres.
Seeds are carried by water and spread ve quickly.
!!!Avoid contact with the sap of this plant it can cause extensive lesions or blistering the skin.

Japanese Knotweed

Grows up to 2-3m in height along roadsid and river corridors throughout the country.
Even a tiny piece of this plant can produce new plant.
Leaves are heart-shaped with a pale stri down the centre.
In Summer cream flowers arise from the ti of the red-flecked stems.

Himalayan Balsam

Grows in dense strands up to 3m high, and is fou widespread across Ireland along banks of rivers.
Seed pods explode scattering seeds.
Dies back in Autumn exposing bare banksides erosion.
White or pink flowers, smooth hollow stem, ov shaped pointed leaves with jagged edges.

Curly waterweed – *Lagarosiphon major*

Found in lakes and slow flowing waterways up to 6m deep.
Spread by fragmentation from one watercourse to another on boat hulls, trailers, outboard motors or angling equipment.
Significant weed stands located in Lough Corrib.

Zebra Mussels

Distinctive stripy shell, very small (1-3cm).
Attach in clusters to hard surfaces – boats, pipes, buoys.
Refer to the Zebra Mussel Standard Operating Procedure.

All photographs courtesy of Central Fisheries Board

Actions for Maintenance Operations

1) Zebra Mussels detected on site

- Where Zebra Mussels are found, remark on the extent of Mussels on the Weekly Report Card and notify the Foreman/Technician.
- Technicians/Engineers to notify Environment Section of location and grid reference.
- Environment Section to update the National Database.

2) Maintenance close to R. Shannon or infested lakes

- Where a machine is working close to the R. Shannon or an infested lake, ensure that prior to the machine transferring to a new site, buckets and tracks are thoroughly cleaned of any material such as silt or vegetation.
- Ganger / Driver to visually inspect the bucket, tracks and any equipment that was in the water to ensure no Mussels are present.

3) Maintenance close to outlets/inlets of any lakes

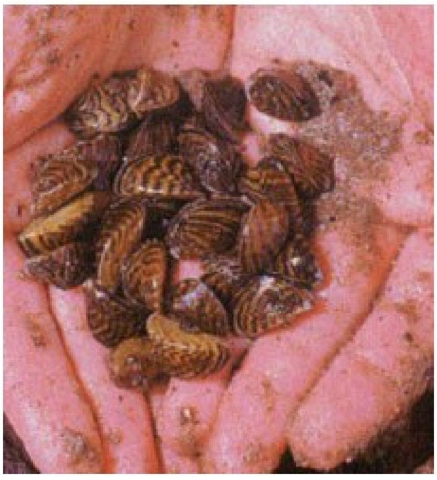
- Where a machine is working close to any lake, ensure that prior to machine transferring to a new site, buckets are clean of any material such as silt or vegetation.
- Ganger / Driver to visually inspect the bucket and other equipment that was in the water to ensure no Mussels are present.

4) Boats and other equipment

- Boats or other water based equipment that is to be transferred between river catchments should be thoroughly cleaned on the outside, drained of any bilge water and inspected for the presence of Mussels.
- If it's suspected that the equipment was in contact with Zebra Mussel waters, steam clean the hull and trailer and leave the boat or equipment out of water for four weeks prior to moving.

OPW Role

Although it is a relatively low risk, OPW could spread Zebra Mussels if aquatic vegetation or excavated material containing Mussels is inadvertently transported to another non-infested channel. Adult Mussels can survive for up to four weeks out of water hence its critical not to transport the same. Larvae are tiny and barely visible but will not survive on a machine bucket if there is no silt, stones or vegetation to shelter it.



Environmental Threat

Zebra Mussels are thumbnail-sized black & orange striped shellfish. They grow into dense clusters and attach to any underwater hard surface. They are an invasive species that damage the natural ecology of the infested waters. They expand into catchments through been transported by man's activities e.g. transferring fishing boats. Once in a particular lake or river, if conditions are favourable, they will multiply and spread with the currents. It is envisaged that they will keep expanding their territory unless man makes a concerted effort to prevent transport of the Mussels into non-infested waters.

OPW Site Audit Form

Region: ______________________ **CDS:** ______________________

Channel (name & code):______________ Section (chg – chg):______________

Foreman: ______________________ Driver(s): ______________________

Auditor: ______________________ **Date**:______________________

Site surveyed from- working bank: ☐ non-working bank: ☐

GPS Reference:______________________ Photographs: Yes ☐ No ☐

Weather Conditions:______________ Water levels: ______________

Wetted/Base width: 0-3m ☐ 3-6m ☐ 6-10m ☐ 10-15m ☐ >15m ☐

Velocity Rating: Slow ☐ Moderate ☐ Fast ☐ Torrential ☐

Bed Type: ______________________ Machine Number:______________________

OPW SOP AWARENESS / COMPLIANCE

Invasive Species SOP: Poor / Fair / Good / Excellent

Protected Species SOP's: Poor / Fair / Good / Excellent

Spill Kit Present: YES / NO

Environmental Drainage Maintenance Constraints

Maintenance Constraints			Working Bank	Non Working Bank
Ownership:	Woodland			
Ownership:	Tillage			
Ownership:	Position of Fencing			
Availability of suitable stone				
Placement of spoil				
Time of year:	Tree cutting			
Time of year:	Wildlife			
Time of year:	Fisheries			
Potential Habitat for Annex II Species		Lamprey		
		Crayfish		
		Otter		
		Pearl mussel		
		Salmon		

Comments on Audit Findings

Maintenance Strategies Achieved - *(based on section recently maintained)*							
	Maintenance Options	Working Bank		Non-working Bank		Instream Channel	
		Suitability	Compliance*	Suitability	Compliance*	Suitability	Compliance*
1	**Protect Bank Slopes**						
	Non-working bank left intact						
	Protect working bank slope						
2	**Restrict Maintenance to Channel**						
	Restrict maintenance to open channel						
	Use of SOPs for lamprey and crayfish						
3	**Spoil Management**						
	Best practice placement of spoil						
	Spread spoil thinly						
	Let water drain from bucket over channel						
4	**Selective Vegetation Removal**						
	Manage instream vegetation (Attn SOPs)						
	Retain marginal vegetation both sides						
	Potential for weed cutting bucket						
	Outside coarse fish spawning *(April 1st to July 1st)*						
5	**Leave Sections Intact**						
	Sections skipped						
6	**Management of Trees**						
	Remove trees blocking flow						
	Observe tree cutting window						
	Remove low hanging branches to known flood level						
	Use chainsaw/secuters for tree removal or thinning						
	Tree thinning management						
	Manage scrub - Otter & Birds SOP						
7	**Manage Berms to form 2 Stage Channels**						
	Retain berms (no maintenance)						
	Top berm to just over summer water flow						
	Re-sod berms where suitable						
	Only narrow berms if OVER-WIDE						
8	**Replace Stone & Boulders**						
	Replace stone and gravel coming out in digging bucket (No New Diggings)						
	Replace large stones/boulders into channel from old spoil						
9	**Working in Gravel Bed Channels**						
	Loosen/toss gravels *(between July 1st & Sept. 30th)*						
	No instream works outside of Fisheries Window *(between July 1st & Sept. 30th)*						
	Use of silt barriers in winter/spring						
10	**Re-profile Channel Bed**						
	Dig pool - riffle sequences						
	Reprofile cross-section						
	Use existing stone to create 'simple' instream structures						

*based on rating system: 0-10, with 0=no compliance and 10=full compliance

Total Compliance (%)

OVERALL COMPLIANCE (%)

Department of the Environment, Heritage and Local Government / An Roinn Comhshaoil, Oidhreachta agus Rialtais Áitiúil

National Parks & Wildlife Service (NPWS) / An tSeirbhís Páirceanna Náisiúnta agus Fiadhúlra, 7 Ely Place, Dublin 2.
Regional Information/Eolas Reigiúnach . . . . (01) 888 2000
Locall/Glaoch Áitiúil: 1890 20 20 21
Fax/Faics: . . . . (01) 888 3272
Internet/Idirlíon: . . . . www.npws.ie & www.environ.ie
E-mail/Ríomhphost: . . . . natureconservation@environ.ie

Eastern Division / Rannán an Oirthir
Divisional Manager: . . . . (01) 8883243
Divisional Ecologist: . . . . (01) 6678256

South Eastern Region/Réigiún an Oirdheiscirt
(Carlow, Kilkenny, Wexford & Wicklow (incl. Wicklow Mountains National Park))
Regional Office: . . . . (0404) 45800
Regional Manager: . . . . (0404) 45802
Deputy Regional Manager: . . . . (0404) 45801
Education Centre: . . . . (0404) 45656
Information Office (Wicklow Mtns Nt Park). . . . (0404) 45425
District Conservation Officer:
(North Wexford & Wicklow) . . . . (0404) 45807
District Conservation Officer:
(Carlow, Kilkenny & Wexford) . . . . (056) 7722135

North Eastern Region/Réigiún an Oirthuaiscirt
(Dublin, Kildare, Laois, Louth, Meath & Offaly)
Regional Manager: . . . . (045) 520 622
Deputy Regional Manager: . . . . (045) 520 644
District Conservation Officer:
(Kildare, Laois & Offaly) . . . . (045) 521 713
District Conservation Officer:
(Dublin, Louth & Meath) . . . . (046) 909 3506

Western Division/Rannán an Iarthair
Divisional Manager: . . . . (091) 704 206
Divisional Ecologist: . . . . (091) 704 208

Western Region/Réigiún an Iarthair
(Mayo, Galway West)
Regional Manager: . . . . (095) 41054
Deputy Regional Manager: . . . . (098) 49996

District Conservation Officer: (Galway West) . . . . (095) 41054
District Conservation Officer: (Mayo). . . . . (098) 49996

Mid Western Region/Réigiún an Lár-Iarthair
(Clare, Galway (except Galway West above)
Regional Office: . . . . (091) 704200
Regional Manager: . . . . (091) 704 201
Deputy Regional Manager: . . . . (091) 870341
District Conservation Officer:(Clare). . . . . (065) 682 2711
District Conservation Officer:
Galway (except Galway West above). . . . . (091) 739654

Southern Division/Rannán an Deiscirt
Divisional Manager: . . . . (021) 4619901
Divisional Ecologist: . . . . (021) 4619903

Mid Southern Region/Réigiún an Lár-Deiscirt
(East Cork, Limerick, Tipperary NR, Tipperary SR & Waterford)
Regional Manager: . . . . (067) 44287
Deputy Regional Manager: . . . . (021) 4619904
District Conservation Officer:
(East Cork, Tipperary SR & Waterford) . . . . (021) 4619905
District Conservation Officer:
(Limerick & Tipperary NR) . . . . (067) 44135

South Western Region/Réigiún an Iardheiscirt
(West Cork & Kerry)
Regional Office: . . . . (064) 31440
Regional Manager: . . . . (064) 70145
Deputy Regional Manager: . . . . (064) 70143
District Conservation Officer:
(North Cork & Kerry). . . . . (064) 33567
District Conservation Officer:
(South & West Cork and South & West Kerry). . . (028) 37347

Northern Division/Rannán an Tuaiscirt
Divisional Manager: . . . . (071) 966 6020
Divisional Ecologist: . . . . (071) 966 6928

Northern Region/Réigiún an Tuaiscirt
(Donegal, Leitrim West & Sligo)
Regional Office: . . . . (074) 913 7090
Regional Manager: ... . (074) 972 1837
Deputy Regional Manager: . . . . (074) 913 7090
District Conservation Officer:
(Donegal Nth & Glenveagh National Park) . . . (074) 913 7440
District Conservation Officer:
(Donegal, Leitrim West & Sligo) . . . . (071) 966 6178

North Midlands Region/An Réigiún Lár Tíre Thuaidh
(Cavan, Leitrim East, Longford, Monaghan, Roscommon & Westmeath)
Regional Office: . . . . (071) 9666178
Regional Manager: . . . . (071) 966 6934
Deputy Regional Manager: . . . . (044) 934 2661
District Conservation Officer:
(Cavan, Leitrim, Longford & Monaghan) . . . . . (049) 433 5750
District Conservation Officer:
(Roscommon & Westmeath) . . . . (044) 933 7007

National Parks & Nature Reserves/Páirceanna Náisiúnta
Ballycroy National Park County Mayo, Lagduff More, Ballycroy, Westport, Co. Mayo. . . . . (098) 49996
Burren National Park, NEPS Building, St. Francis Street, Ennis, Co. Clare . . . . (065) 6822662
Connemara National Park, Letterfrack, Co. Galway . . . . (095) 41054
Coole Park Nature Reserve, Gort, Co. Galway . . . . (091) 631 804
Glenveagh National Park, Church Hill, Letterkenny, Co. Donegal . . . . (074) 9137090
Killarney National Park, Muckross House, Killarney, Co. Kerry . . . . (064) 31440
Wexford Wildfowl Reserve, North Slob, Wexford . . . . (053) 9123129
Wicklow Mountains National Park, Kilafin, Laragh, Co. Wicklow . . . . (0404) 45800

Inland Fisheries Ireland March 2011

IFI Region	Director	Address	Telephone	Region/Scheme
IFI Blackrock	William Walsh	15a Main Street Blackrock Co. Dublin	01 2787022	East: Glyde & Dee, Boyne, Blackwater, Bally-Teigue
IFI Ballina	John Connelly	Ardnaree House Abbey Street Ballina Co. Mayo	096 22788	West: Moy, Bonet
IFI Ballyshannon	Dr. Milton Matthews,	Station Road Ballyshannon Co. Donegal	071 9851435	West: Donegal schemes, Kilcoo, Duff
IFI Limerick	Sean Ryan	Ashbourne Business Park Dock Road Limerick	061 300238	East: Inny, Brosna West: Boyle, Ballyglass South: Killimor, Carrighahorig, Nenagh, Groody, Maigue, Deel, Feale
IFI Macroom	Dr. Patrick Buck	Sunnyside House, Macroom Co. Cork	026 41221	South: Maine, Owvane
IFI Clonmel	Suzanne Campion	Anglesea Street Clonmel Co. Tipperary	052 80055	East: Brickey
IFI Galway	Amanda Mooney	The Weir Lodge Earl's Island Galway	091 563118	West: Corrib Headford, Mask,
IFI	Dr. Ciaran Byrne	Unit 4 Swords Business Campus Balheary Rd Swords Co. Dublin	01 8842600	All
EREP Project Manager	**Dr. Karen Delanty**	**Unit 4 Swords Business Campus Balheary Rd Swords Co. Dublin**	**01 8842624**	**All**

(Note: Completed flood relief schemes are not listed but proposed works should be discussed with the relevant local IFI)

OPW Bridges (numbering 170) intersecting National Primary Roads.

Scheme	Channel ID	Bridge No.	National Route type	Bridge Name
Glyde and Dee	C2 (7C)	B80	N01	
Glyde and Dee	C2 (7E1)	B839	N01	
Glyde and Dee	C2 (7E1)	B840	N01	
Broadmeadow and Ward	C2/1	B230	N02	
Broadmeadow and Ward	C2/1	B239	N02	
Broadmeadow and Ward	C2	B204	N02	Coolatrath br.
Broadmeadow and Ward	C2/3	B243	N02	
Broadmeadow and Ward	C1/6/1	B86	N02	
Broadmeadow and Ward	C1/6/1/1	B96	N02	
Broadmeadow and Ward	C1/6	B68	N02	
Broadmeadow and Ward	C1	B16	N02	
Boyne	C1	B4	N02	Slane br.
Glyde and Dee	C2 (7H)	B101A	N02	
Glyde and Dee	C2 (17)	B179	N02	
Glyde and Dee	C2 (14B)	B118	N02	
Glyde and Dee	C2 (14)	B867	N02	
Glyde and Dee	C2 (1)	B30	N02	
Glyde and Dee	C2 (13)	B111	N02	
Glyde and Dee	C2 (16B4)		N02	
Glyde and Dee	C1 (1)	B15	N02	Aclint Br
Glyde and Dee	C29 (2)	B441	N02	
Glyde and Dee	C29 (3)	B443	N02	
Glyde and Dee	C25 (8)	B341	N02	
Glyde and Dee	C25 (7D1)	B672	N02	
Monaghan Blackwater	C1/1/5	B7	N02	
Monaghan Blackwater	C1/1/5/6/1	B1	N02	
Monaghan Blackwater	C1/3/5/2	B8	N02	
Monaghan Blackwater	C1/3/6/3	B1	N02	Hoaf Br
Boyne	C1/8/24	BX1	N03	
Boyne	C1/8/23	B733	N03	
Boyne	C1/8/21	B723	N03	
Boyne	C1/8/16	B644	N03	
Boyne	C1/8	B126	N03	Clavens Br
Boyne	C1/8/8	B294	N03	
Boyne	C1/12/1	B875	N03	Dillon's Br
Boyne	C1/12/7	B915	N03	
Owenmore	Behy Bridge	BX1	N04	
Boyle	C6/7/5	B2	N05	Ballanagare Br
Boyle	C6/7/1/4	B2	N05	
Boyle	C6/7/1	B3	N05	Cloonshanville Br
Boyle	C1/3/2/1	B4	N05	
Boyle	C1/9/1	B1	N05	
Boyle	C1	B4	N05	Old Lung Bridge
Boyle	C1/8	B1	N05	New Lung Bridge
Boyle	C1/45	B8	N05	
Moy	C1/31/2	B3	N05	
Moy	C1/31	B4	N05	
Moy	Not on a channel	B2	N05	Trimoge
Moy	Not on a channel	B2	N05	
Moy	Not on a channel	B1	N05	
Moy	C1/30/3/1	B1	N05	
Moy	C1/28/2	B3	N05	
Moy	C1/28/1	B4	N05	
Moy	C1/25	B6	N05	
Moy	C1/23/3	B2	N05	
Moy	C1/23	B9	N05	
Moy	Not on a channel	B1	N05	
Moy	C1/21/1/5/2/2	B3	N05	
Moy	C1/21/1/5/2/11	B2	N05	
Moy	C1/21/1/5/1/15	B1	N05	

Moy	C1/21/1/5/2/18	B1	N05	
Moy	C1/21/1/5/2/19	B2	N05	
Moy	C1/21/2/5/2/20/4	B1	N05	
Boyle	C1/44/15	B2976	N06	
Boyle	C1/44/17	B2984	N06	
Boyle	C1/64/1/11/6	B3337	N06	
Boyle	C1/64/1/11	B3303	N06	Miltownpass Br.
Boyle	C1/64/1/11/4	B3319	N06	
Boyle	C1/64/1/11/4/2	B3331	N06	
Boyle	C1/64/1/13/2	B3330	N06	
Boyle	C1/64/1/13	B3372	N06	Rochfort Br.
Boyle	C1/64/1/13/4	B3384	N06	
Brosna	C27 (1)	B150	N06	
Brosna	C1 (1)	B11	N06	Kilbeggan Br.
Brosna	C17 (1)	B143	N06	
Brosna	C17 (SE)	B726	N06	
Brosna	C17 (5)	B138	N06	New Br
Brosna	C17 (4)	B135	N06	
Corrib Clare	C1	B3	N06	Quincentennial Br.
Nenagh	C1/9	B23	N07	Ollatrim Br
Nenagh	C1/9/24	B4	N07	
Monaghan Blackwater	C1/1/6/1	B11	N12	Tyholland Br
Blanket Nook	C1/3	B23	N13	
Swilly embankments	E9	B1	N14	
Swilly embankments	C1/5	B9	N14	
Deele and Swillyburn	C1	B6	N14	
Deele and Swillyburn	C1/11	B19	N14	
Deele and Swillyburn	C2	B20	N14	
Abbey	C1/4	B39	N15	
Abbey	C1/4	B31	N15	
Abbey	C1/3A	B30B	N15	
Abbey	C1/2	B21 - B23	N15	
Abbey	C1/1	B18	N15	
Duff	C1	B1	N15	
Bonet	C1/12/3	B1	N16	
Bonet	C1/12	B5	N16	
Bonet	C1/12	B4	N16	
Bonet	C1/12	B2	N16	
Bonet	C1	B5	N16	
Bonet	C1/13/2	B1	N16	
Bonet	C1/13	B1	N16	
Moy	C1/50/2	B3	N17	
Moy	C1/50	B4	N17	
Moy	C1/48/3	B2	N17	
Moy	C1/48	B3	N17	
Moy	C1/45/4	B2	N17	
Moy	C1/45	B13	N17	
Moy	C1/30/5/9	B3	N17	
Moy	C1/30/5/9	B15	N17	
Corrib Mask	CM4/43/4	B2	N17	
Corrib Mask	CM4/34	B10	N17	
Corrib Mask	CM4/34/2	B2	N17	
Corrib Clare	C3/30	B8	N17	
Corrib Clare	C3/30/4	B1	N17	
Corrib Clare	C3/26	B2	N17	
Corrib Clare	C3/26/9	B1	N17	
Corrib Clare	C3/26/1	B3	N17	
Corrib Clare	C3/12/2	B1	N17	
Corrib Clare	C3	B14	N17	
Corrib Clare	C3	B2	N17	Claregalway bridge
Fergus	D7	B3	N18	
Owenagarney	C2	B1	N18	
Owenagarney	C4	B3	N18	
Coonagh Embankments	C10	B9	N18	

Coonagh Embankments	D13	B113	N18	
Coonagh Embankments		B1	N18	
Maigue	C1/36	B1	N20	Helena's br.
Maigue	C1/37/1	B3	N20	
Maigue	C1/37	B1	N20	
Maigue	C1	B23	N20	Creggane br.
Maigue	C1/33	B1	N20	Cappanafaha br.
Maigue	C1/30	B2	N20	Ballynabanoge br
Maigue	C1/26	B1	N20	
Maigue	C1/15	B10	N20	
Maigue	C1/10/5	B3	N20	
Maine	C1/28	BX1	N21	
Maine	C1/34	B117	N21	
Maine	C1/35	BX2	N21	
Deel SR	C12/2/2	B125	N21	
Deel SR	C12/2/2/2	B127	N21	
Deel SR	C12/2/1	B123	N21	
Deel SR	C10	B95	N21	Ballyfraley br.
Deel SR	C8	B76	N21	Reens br.
Maigue	C1/17/10	B1	N21	
Maigue	C1/17/8	B2	N21	
Maigue	C1/17/5	B1	N21	
Maigue	C1	B1	N21	Adare br.
Maigue	C1/15	B5	N21	
Maine	C1	B3	N22	Maine br.
Maine	C1/32	B110	N23	Dysert br.
Maine	C1/33	B114	N23	Killfinnaun br.
Maine	C1	B9	N23	Herbert br.
Groody	C1/4	B29	N24	
Groody	C1	B4	N24	
Groody	C1/7	B53	N24	
Groody	C1/9	B56	N24	
Moy	C1/9/1	B1	N26	
Moy	C1/9	B2	N26	
Moy	F/282	B	N26	
Moy	C1/14	B1	N26	
Moy	RIVER	B3	N26	
Moy	C1/37	B1	N26	
Moy	C1/38	B1	N26	
Moy	RIVER	B2	N26	Cloongullaun br.
Moy	C1/39	B3	N26	
Moy	C1/39	B6	N26	
Moy	C1/39	B9	N26	
Moy	C1/39/3	B1	N26	

Otter Wildlife Passes and OPW Drainage Channels

- It has been brought to the attention of the OPW that there may be a need for small mammal passes on some of the maintained channels.

- The National roads constitute less than 6 percent of roads in this country, approx. 3 National Primary and 3 percent National Secondary. In spite of this they a carry over 42 percent of the traffic. It is for this reason that the focus will be on the National Primary road crossings.

- The national road kill survey was analysed and the data from the web site "www.biology.ie" was cross-referenced against OPW channel locations and the results were inconclusive, as the web page is not widely used. It appears for now that OPW channel road crossings have no affect on the deaths of otters as per this information.

Next Steps:

1) Consult NPWS throughout all regions to review any evidence of otter road kills on National Primary roads or are they aware of any other such road deaths.

1. Where there appears to be mammal deaths on National Primary roads that intersect OPW channels it will be seriously considered to install in the bridge (where possible) a small mammal pass to allow ease of access for otters.

Otter Habitat Disruption

- Otters, along with their breeding and resting places, are protected under the provisions of the Wildlife Act, 1976, as amended by the Wildlife (Amendment) Act, 2000. They are also included in Annex I and Annex IV of the Habitats Directive, which is transposed into Irish Law in the European Communities (Natural Habitats) Regulations (S.I. 94 of 1997), as amended.

Otter Pass Details

- Mammal Ledges and underpasses should be constructed parallel to the watercourse.
- Underpasses should be of a diameter of 600mm up to a length of 20m. Where lengths exceed this the pipe should be increased to 900mm diameter
- An underpass should be no more than 50m of the watercourse with channels or fencing guiding the animals to it.

Where there is sufficient space under the bridge for a ledge the following should be provided:

- Fencing: See "figure 1; Specification for Mammal Resistant Fencing" in the NRA, National Roads Authority, Guidelines for the Treatment of Otters Prior to the Construction of National Road Schemes, for more detail. Also, Design Manual for Roads and Bridges, DMRB Volume 10, Section 1, Part 5, Chapter 9.
- A bolt on ledge can be used under a bridge where there is no dry passage. The bolt on ledge should provide otters with a dry walkway of between 300mm and 450mm wide, constructed from 4.5mm Durbar patterned galvanised plate.
- At some sites, considerations of responsibility, cost, aesthetics or practicality might indicate the use of a solid ledge; this is most likely where an existing otter-ledge has proved to be sited too low to offer dry passage at spate conditions. A solid ledge can be created in 3 ways; concrete bagging, shuttering plus new concrete and concrete blocks.
- See (OPW, 2007), (DMRB, 2001) and (NRA 2006) for further Details

References

- NRA (2006) – National Roads Authority, Guidelines for the Treatment of Otters Prior to the Construction of National Road Schemes.
- NRA (2005) – National Roads Authority, Guidelines for the Crossing of Watercourses During the Construction Of National Road Schemes.
- OPW (2007) – Series of Ecological Assessments on Arterial Drainage Maintenance No. 4, Ecological Impact Assessment (EcIA) of the Effects of Statutory Arterial Drainage Maintenance Activities on the Otter (Lutra lutra).
- OPW (2006) – Screening of Natura 2000 Sites for Impacts of Arterial Drainage Maintenance Operations. Environment Section, Engineering Services, Office of Public Works.
- DMRB (2001) - Design manual for roads and bridges (DMRB). Volume 10, Section 4 Environmental Design and Management Nature Conservation. Part 4 HA 81/99 Nature conservation advice in relation to otters. Section 1, Part 9 HA 81/99.

B4 Habitat Suitability Survey of Kingfisher

Habitat suitability survey of Kingfisher (Alcedo Atthis)

An annex 1 species on the EU Bird directive

On the

Dunkellin River, Aggard Stream and the Monksfield River

Prepared by Shane O'Neill

Commissioned by Galway County Council and RPS

1.0 Introduction

RPS were commissioned by Galway County Council to carry out a survey of the site of some proposed drainage works on the Dunkellin River, the Aggard stream and the Monksfield River in county Galway. The following report is concerned with the potential of the study area to support Kingfishers, for this reason a dedicated survey for Kingfisher was conducted.

1.1 Aims:

The aim of this survey was to assess river and bank side habitat for potential to support Kingfisher on the three rivers in the study are and to search for signs of use by Kingfisher (Alcedo Atthis). This survey will contribute to ascertaining whether proposed drainage works on these systems can proceed with minimal impact on the kingfisher and kingfisher habitat.

2.0 Methodology

The methodology of this survey was to walk the banks of The Dunkellin River, The Aggard Stream and The Monksfield River looking for any signs of Kingfisher habitat while looking and listening for the birds themselves. As this survey was carried out in November it was going to be unlikely to see any birds so emphasis was put on recording nest banks and feeding perches.

2.1 Desk study

A search was made for records of Kingfisher in relevant 10 kilometre square MXX in *'The New Atlas of Breeding Birds in Britain and Ireland: 1988-1991' (Gibbons et al., 1993) and 'The Atlas of Wintering Birds in Britain and Ireland:1981-1984' (Lack, 1986). In addition, unconfirmed data from the Birdwatch Ireland bird Atlas 07 – 11 website was reviewed for any relevant Kingfisher records.*

Relevant squares in this survey were IM41, IM42, IM 51 and IM52. The Atlas of Breeding Birds in Britain and Ireland 1968-1972 shows probable breeding in some relevant squares (IM41, IM51 and IM52). The Atlas of Wintering Birds in Britain and Ireland 1981-1984 shows that there were confirmed reports of Kingfisher in two of these squares (IM41and IM51).There are unconfirmed reports of breeding

Kingfisher in The Birdwatch Ireland Atlas 2007-2011 in two squares (IM 51 and IM 52). An additional Search of the NPWS site synopsis of The Rathasann Turlough SPA showed no record of Kingfisher. Jacinta Murphy NPWS local ranger has also indicated that they have no records of Kingfisher in the surveyed area.

Contacts: Jacinta Murphy NPWS, Loughrea, Co. Galway.

Olivia Crow BWI, Kilcool, Co. Wicklow.

Laura Mc Nulty BWI, Kilcool, Co. Wicklow

Jen Fisher Ecologist, Kilcolgan, Co Galway

2.2 Fieldstudy

The rivers and bank side habitats within the study area were assessed by means of a field survey which was conducted on the 14 -16 of November 2011. The banks of the sections of river in the study area were carefully walked by an ornithological fieldworker who searched for signs or calls of Kingfisher utilising the habitat and carried out a visual assessment of the habitat, recording suitable habitat for this species. Suitable habitats include slow moving water, feeding perches, tall vertical banks comprising of soft material which could facilitate nest burrowing. As this survey was carried out in November the river systems were somewhat swollen so *much emphasis was put on suitable perches and banks. Grid references for suitable perches and banks were recorded.*

The Weather Conditions during the survey are shown in the table below (Figure 1.1) generally the weather was overcast with light wind, no rain and good visibility. These conditions were considered to be suitable for Kingfisher survey.

	14/11/11	*15/11/11*	*16/11/11*
Cloud	*100%*	*100%*	*100%*
Wind	*2*	*1*	*2*
Rain	*0*	*0*	*0*
Visibility	*Good*	*Good*	*Moderate/Good*

Site Descriptions

3.0 Dunkellin River

The Dunkellin River is situated in East Galway and the section surveyed was between Craughwell and Kilcolgin. Note: this also takes in a small section of the Aggard stream.

Section 1: The area covered started on the river a half a kilometre east of the R446 bridge in Craughwell and goes west to where it intersects with the Aggard Stream, it then travels southeast to the Aggard Bridge on the R347.(see map 0007)

This section of the Dunkellin River had sloping banks 1-2 meters high for the majority of its course, with some vertical banks of rock with an abundance of loose spoil that makes up part of the bank in places and is dumped on top of the bank in others. This spoil is from previous works. Thick scrub (WS1) covered much of the banks on this river, making access to the river difficult. The section of Aggard stream included has rocky banks from 1-3 metres in height and is a FW2 (depositing/lowland river). It also has thick WS1 (scrub) on the bank sides.

scan0007.pdf

In this section the banks are deemed unsuitable for nesting as they are too rocky. Some suitable perches were found, one with evidence of use (droppings on it) but no confirmation of what species of bird was using it. (See pic.1

Pic:1.0

Section 2: Rahasane town land to Dunkellin Bridge.

Section 2 covers the area of the Dunkellin River between Rahasane town land and Dunkellin Bridge (see map 20001). The eastern end of this section was composed of vertical banks 1-4 meters high of rock and scrub (WS1) which had spoil up to 15 feet dumped on top of the banks in places, *along both banks. As the river travels west the bank height was reduced and the scrub was less dense. The banks in the vicinity of Dunkellin Bridge were reduced to approximately 0-1/2 metre in height. The river had broken its banks in places on both sides of this section and some flooding was evident in the adjacent fields. These look like annual flood plains.*

There were two banks on this section that were deemed suitable for nesting one on the southern side and one on the Northern side pictured 2.0 and 2.1 bellow (see table below for grid reference) as for the rest of the section it was unsuitable. There were some perches that were deemed suitable but not confirmed.

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pic:2.0

Pic:2.1

Section 3 - Dunkellin Bridge to Killeely Beg Bridge (see map0008) .

Works have also been carried out on this section of the river. Vertical rock armoured banks were noted on this section; these banks were up to 4 meters in places. Scrub and spoil was noted on both sides of the river banks, scrub has grown up through the spoil in places. As the river travels east the bank height was reduced with a maximum height of approximately 1 meter. Some of these banks have been built up to this height in places.

There were no banks deemed suitable in this section as it was too rocky. Some perches were suitable but the river current was strong in this section.

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Section 4 – Killeely Beg bridge to N18 Bridge(see map 0001)

Section 4: The banks along this section were sloped and between 0-1 metres in height. Bank side vegetation was composed predominantly of reeds. Some thinly dispersed scrub was also recorded along this section. The river was much wider and slower along this section and some built up stone banks for flood protection were evident.

The eastern part of this Section in the vicinity of Killeely Beg Bridge was best classified as an eroding upland river (FW1); however the western portion was considered to be more consistent with a depositing lowland river (FW2).

The banks in this section were not deemed suitable for nesting in. Some suitable perches were found but the current was too fast. It is possible that in the breeding season the water level would be suitable for feeding.

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On the Dunkellin River there was no Kingfisher sited or heard, five suitable perches were recorded (this was a noted sample of many possible perches). There was two possible nesting banks recorded in section 2, between Rinn Bridge and Dunkellin Bridge (see table below for grid references) one was about two and a half meters tall and about four meters long with suitable substrate. The other one was about six meters long and two high with suitable substrate. The combined length of the surveyed area on the Dunkellin River was approximately seven kilometres long. For the most part the river was unsuitable for nesting because of its rocky banks and thick scrub but had some potential Kingfisher habitat on it. Other species recorded were signs of Otter (slides and scat) in two locations on The Dunkellin River at IM50597, 19820 and IM43484 18438, Dipper seen at IM50446, 19710 and a Moorhen seen at IM45229 18450.

Pic:3.0

Dates	Rivers	Sections	Grid Ref	Perch	Bank	Pools
14/11/11	Dunkellin River	1	IM 51451/20010	✓		
14/11/11	Dunkellin River	1	IM 50319/19664	✓		
14/11/11	Dunkellin River	2	IM 45316/18428	✓		
14/11/1	Dunkelli	2	IM		✓	

1	n River		44773/18674			
14/11/1 1	Dunkelli n River	2	IM 44763/18697		✓	
15/11/1 1	Dunkelli n River	4	IM 42501/18691	✓		
15/11/1 1	Dunkelli n River	4	IM 42586/18691	✓		

3.1 Monksfield River

The Monksfield River is situated northeast of Ardrahan and South of Craughwell. The section surveyed was between Ballyboy town land and Monksfield town land, see map (0002) below. The Monksfield River is discussed in section 5 below

Section 5 – Monksfield River

Section 5 The southern portion of section 5 in the vicinity of Ballyboy was flooded and thus was not possible to properly *survey. Some parts of this river had been recently dredged (see section map below) and was more consistent with a drainage ditch (FW4) with very little water present. The banks on this section were sloped and composed of clay. There are some hedge-rows still intact on the banks. No obvious or recent dredging had taken place on the northern end of this river and the river was completely choked with aquatic vegetation during the survey. Very little water was present along this section of the river and bank height varied between 0-2 meters and was sloped.*

The Monksfield River had low sloping banks of clay unsuitable for nesting Kingfisher. These banks had been modified recently northeast of the flooded area at Ballyboy, this flooded area maybe a turlough (see map below for modified areas and flooded areas) this modification has changed the characteristics of the river to that of a drain with little water running in it. On the North-eastern end of the river there are sparse trees and shrubs leaning over the river and these look like perches (two noted) but for the most part the Monks field River is unsuitable for Kingfisher. The length of river surveyed on the Monksfield was approximately 5.5 kilometres

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Pic:4.0

Dates	Rivers	Sections	Grid Ref	Perch	Bank	Pools
15/11/11	Monksfield River	5	IM 50065/15051	✓		
15/11/11	Monksfield River	5	IM 50415/15419	✓		

3.1.3 The Aggard stream The Aggard Stream is situated South of Craughwell and Northeast of Ardrahan. The section of the river surveyed was from the intersection with The Dunkellin River to Ballylin west. It flows south trough Aggard Beg and veers sharply east through Ballyin west.

Section 6: Aggard Stream southeast section (see map 0003)

Section 6 covers a one kilometre section east of the bridge at Ballylin West. Parts of the bank sides in this section were completely covered over with scrub and hedgerow. Some small clear flowing pools of moderate flow were considered suitable for kingfisher foraging. The Banks along this stretch of river were approximately 0-1 meters in height and not deemed suitable for nesting.

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Section 7: Aggard Stream from Aggard Bridge to Aggard Beg Bridge(see map0004/0005 below)

This river has sloping banks form 0-4 meters high just south of Aggard Bridge. Going south, these banks level out to 1-2 meters sloping. There are some trees and scrub scattered along this section that provide some perches. Three possible nesting banks on this section of depositing Lowland River.

scan0004.pdf scan0005.pdf

Section 8: Aggard Stream from the Bridge at Ballynamannin to Ballylin West Bridge (see map 0006)

Banks from 0-4 meters high of armoured rock at the start of this section levelling out to 1-2 meter sloping banks after about half a Kilometre. As the river rounds the corner and meets the Monksfield River it begins to choke up again with aquatic vegetation. It then narrows to a foot wide fast running stream. Some possible perches were noted and one nest site was recorded.

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The Aggard Stream has two possible nesting banks that were recorded. There were no nest holes in these banks that could *be seen. Ten possible perches were recorded; again these were a noted sample of many possible perches. The Aggard Stream is a depositing lowland river with some good Kingfisher habitat. On the Aggard stream there are some manmade perches; these are barriers to stop cattle from travelling up or down the river, consisting of telegraph poles and gates that sit in the river or just above the river to create perches. Some of these manmade perches have droppings on them there is no confirmation of what bird made the droppings. Other species seen, Otter slide and scat at IM50391, 16392, Dipper at IM50203,19566 and Moorhen at IM50416,19198 and IM50097,*

pic:5.0

Pic:5.1

Pic:5.2

Pic:5.3

15/11/11	*Aggard Stream*	*6*	*IM 51225/15950*	✓		
16/11/11	*Aggard Stream*	*7*	*IM 50097/18212*	✓		
16/11/11	*Aggard Stream*	*7*	*IM 50350/17945*	✓	✓	
16/11/11	*Aggard Stream*	*7*	*IM 50346/17825*		✓	
16/11/11	*Aggard Stream*	*7*	*IM 50359/17462*	✓		
16/11/11	*Aggard Stream*	*7*	*IM 50312/17393*	✓		
16/11/11	*Aggard Stream*	*7*	*IM 50331/17233*	✓		
16/11/11	*Aggard Stream*	*7*	*IM 50540/16788*	✓		
16/11/11	*Aggard Stream*	*8*	*IM 50378/16359*	✓		
16/11/11	*Aggard Stream*	*8*	*IM 50344/16133*	✓		
16/11/11	*Aggard Stream*	*8*	*IM 05797/15960*	✓		

Conclusions

- *No Kingfisher were seen or heard in any of the eight sections surveyed.*
- *Kingfisher records for the relevant 10 kilometre square Mxx are available as unconfirmed Breeding Bird Atlas data from the Birdwatch Ireland bird Atlas 07 – 11 website. In addition confirmed reports are in The Atlas of Breeding Birds of Britain and Ireland 1968-1972 and The Atlas of Wintering Birds of Britain and Ireland 1981-1984.*
- *No nest holes were seen on any of the rivers surveyed but Kingfisher could nest just off the river outside of the survey area.*
- *As the survey was carried out in November it is impossible to rule out the presence of Kingfisher during the breeding season*
- *Suitable fishing habitats may be present, however as water levels were high it is possible that these habitats were underestimated*
- *As this survey has shown there are numerous suitable feeding perches and some nesting banks along the surveyed sections?*

- *Suitable banks were identified in sections 2,7and. No suitable banks were present in sections 1,3,4,5,6 and 8*
- *A large number of suitable fishing perches were identified in all sections surveyed. On the Monksfield River however these probably were just branches that were hanging over the river and look like perches. As the river looked unsuitable for Kingfisher.*

Recommendations: It is recommended that a follow up survey be carried out on the Dunkellin River and Aggard stream during the breeding season. The Monksfield River is unsuitable habitat for Kingfisher. It may be better to concentrate on the two other rivers surveyed.

Kingfisher breeding season is between February and July with 2-3 broods produced during this time. Work on the Dunkellin River, Aggard stream and Monksfield River should take place outside this time so as not to disturb any breeding birds.

It is recommended that the possible nest banks be avoided where possible. Since there were no nest holes seen during this survey maybe supervision of sensitive areas during the work may be possible, or target surveys of sensitive sites if the work has to be carried out during the breeding season.

On the Dunkellin River is a possible nesting bank on the South bank at IM44773, 18674 and one opposite on the North bank at IM44763, 18697 that will be in one of the areas of proposed work. This would mean that it may be disturbed,

in such a case it is recommended that the bank be replaced by a man made one.

Note: Man-made banks were proven successful in Druids Glen in 2005 where a nesting pair took up residence within a few weeks of completion of works (ref Bray People 2005).

It is recommended that the possible nest banks be avoided where possible. Since there were no nest holes seen during this survey maybe supervision of sensitive areas during the work may be possible, or target surveys of sensitive sites if the work has to be carried out during the breeding season.

APPENDIX C

Aquatic Ecology

C1 Evaluation Criteria

Table C.1 - Ecological Valuation of Aquatic Resources[1]

Relevant Criteria	Classification
International Importance: • 'European Site' including Special Area of Conservation (SAC), Site of Community Importance (SCI), Special Protection Area (SPA) or proposed Special Area of Conservation. • Features essential to maintaining the coherence of the Natura 2000 Network. • Site containing 'best examples' of the habitat types listed in Annex I of the Habitats Directive. • Resident or regularly occurring populations (assessed to be important at the national level) of species of animal and plants listed in Annex II and/or IV of the Habitats Directive. • Salmonid water designated pursuant to the European Communities (Quality of Salmonid Waters) Regulations, 1988, (S.I. No. 293 of 1988). • Major salmon river fisheries	**A**
National Importance: • Site designated or proposed as a Natural Heritage Area (NHA). • Statutory Nature Reserve. • Refuge for Fauna and Flora protected under the Wildlife Acts. • National Park. • Statutory Nature Reserve; Refuge for Fauna and Flora protected under the Wildlife Act; and/or a National Park. • Resident or regularly occurring populations (assessed to be important at the national level) of species protected under the Wildlife Acts; and/or; species listed on the relevant Red Data list. • Site containing 'viable areas' of the habitat types listed in Annex I of the Habitats Directive. • Major trout river fisheries • Commercially important coarse fisheries • Waterbodies with high amenity value.	**B**
County Importance: • Area of Special Amenity. • Area of High Amenity, or equivalent, designated under the County Development Plan. • Resident or regularly occurring populations (assessed to be important at the County level)10 of species of animal and plants listed in Annex II and/or IV of the Habitats Directive, and/or; species protected under the Wildlife Acts; and/or; species listed on the relevant Red Data list. • Site containing area or areas of the habitat types listed in Annex I of the Habitats Directive that do not fulfil the criteria for valuation as of International or National importance. • County important populations of species, or viable areas of semi-natural habitats identified in the national or Local BAP if this has been prepared. • Sites containing semi-natural habitat types with high biodiversity in a county context and a high degree of naturalness, or populations of species that are uncommon within the county. • Sites containing habitats and species that are rare or are undergoing a decline in quality or extent at a national level.	**C**

[1] (adapted from NRA, 2009)

Relevant Criteria	Classification
Local Importance (higher value): • Locally important populations of priority species or habitats or natural heritage features identified in the Local BAP, if this has been prepared; • Resident or regularly occurring populations (assessed to be important at the Local level) of species of animal and plants listed in Annex II and/or IV of the Habitats Directive, and/or; species protected under the Wildlife Acts; and/or; species listed on the relevant Red Data list. • Sites containing semi-natural habitat types with high biodiversity in a local context and a high degree of naturalness, or populations of species that are uncommon in the locality; • Sites or features containing common or lower value habitats, including naturalised species that are nevertheless essential in maintaining links and ecological corridors between features of higher ecological value. • Sites of 'High' water quality status (Q4-5, Q5) • Water body with some fisheries values and potential salmonid habitat.	**D**
Local Importance (lower value): • Sites containing small areas of semi-natural habitat that are of some local importance for wildlife; • Sites or features containing non-native species that are of some importance in maintaining habitat links. • Waterbody with no fisheries value and poor fisheries habitat.	**E**

C2 Target Notes

Table C2.1 - Dunkellin – Craughwell River – Target Notes (20/21-7-2011)

Code	Target Note	Photo Code
1	Wide glide upstream of Kilcolgan Bridge (Photo 8743a), with near total macrophyte cover (including: *S. emersum*, *Berula*, *A. nodiflorum*, and moss just upstream of the bridge (Photo 8744a). Swift laminar flow at this point at the time of survey, but stretch is subject to tidal influence and backs up. This is an important angling area as it contains some good holding water for salmon and seatrout.	8743a, 8744a
2 **3** **4**	This is a change point in the channel where the wider glide which is 'backed-up' from Kilcolgan Bridge meets the base of a narrower cascade/run from upstream (Photo 8745). Here the substrate is of moss covered cobble and small boulder with pockets of gravel. At the top of this rapidly flowing reach the channel widens and the gradient levels allowing marginal stands of S. erectum to develop. Above this again as far as Kilkeely the gradient is steady and the straight channel is divided into weir (Photo 8724), riffle/run (8725), glide (8726) sequences with considerable distances between each weir step. 0+ salmonids were observed sheltering among the cobble substrates along this stretch. Algal and moss cover tended to be highest in the rapids and at weirs and reduced in the slower glide stretches.	8724 8725 8726 8745
5	Salmon Counter	8633a
6	Long glide upstream, deep toward channel centre – good fish holding stretch	8727
7	Continuation of glide upstream to this point where the channel widens with marginal heavy stands of *S. erectum*, *Phalaris* and *Apium* marginally (right bank). The substrate is of cobble and boulder with a light to moderate cover of silt in places – depth 0.6-0.8m.	8732
8	Short, deep (~1.5m) pool at the head of the glide/pool stretch of Pt 7, area. It is situated just below a long rapid/run. (Photo 8734a looking downstream)	8734a
9	Long run which ends in pool at Pt 8; this marks a change to a steady steeper gradient upstream. Shallow ~0.3m bed of boulder and cobble with much algal and moss cover – good 0+/1+ habitat (Photo 8735 – view upstream)	8735
10	Spawning below Dunkellin ; view upstream toward bridge from site where IFI recently found salmon spawning redds (in 2010)	8640
11	View downstream toward Dunkellin Bridge showing shallow run over cobble, gravel and boulder, with salmon spawning area in the distance below the bridge (8676). View upstream from about the same point toward the downstream end of a shallow glide where a now disused eel-trap is situated (Photo 8674)	8676 8674
12, **13**	Narrow glide within banks of large boulder/block (8677). Substrate of maerl-covered cobbles, with little or no finer material – very slack flow upstream of Pt 13, depth up to 1m+ centrally.	8677
14	From this point upstream the channel gradually widens, and the flow slackens (8682). Also there is finer material close to the banks to facilitate the rooting of marginal emergent aquatics (8681), while the slacker flow and greater microhabitats increases the diversity of submerged and floating aquatic macrophytes as one moves upstream toward the large pool area near Pt 19. In-channel this area has *S. emersum* submerged, with good marginal cover of *Apium nodiflorum*, *Myosotis scorpioides,* and *Rumex* sp. occasional *Oenanthe fluviatile*/*O. aquatica* (?). Also patches of floating *Nuphar* and loose sparse stands of *S. erectum*.	8681 8682
15,	Downstream end (Pt 15) and upstream end (Pt 16) of a *Sparganium erectum* bed	8683

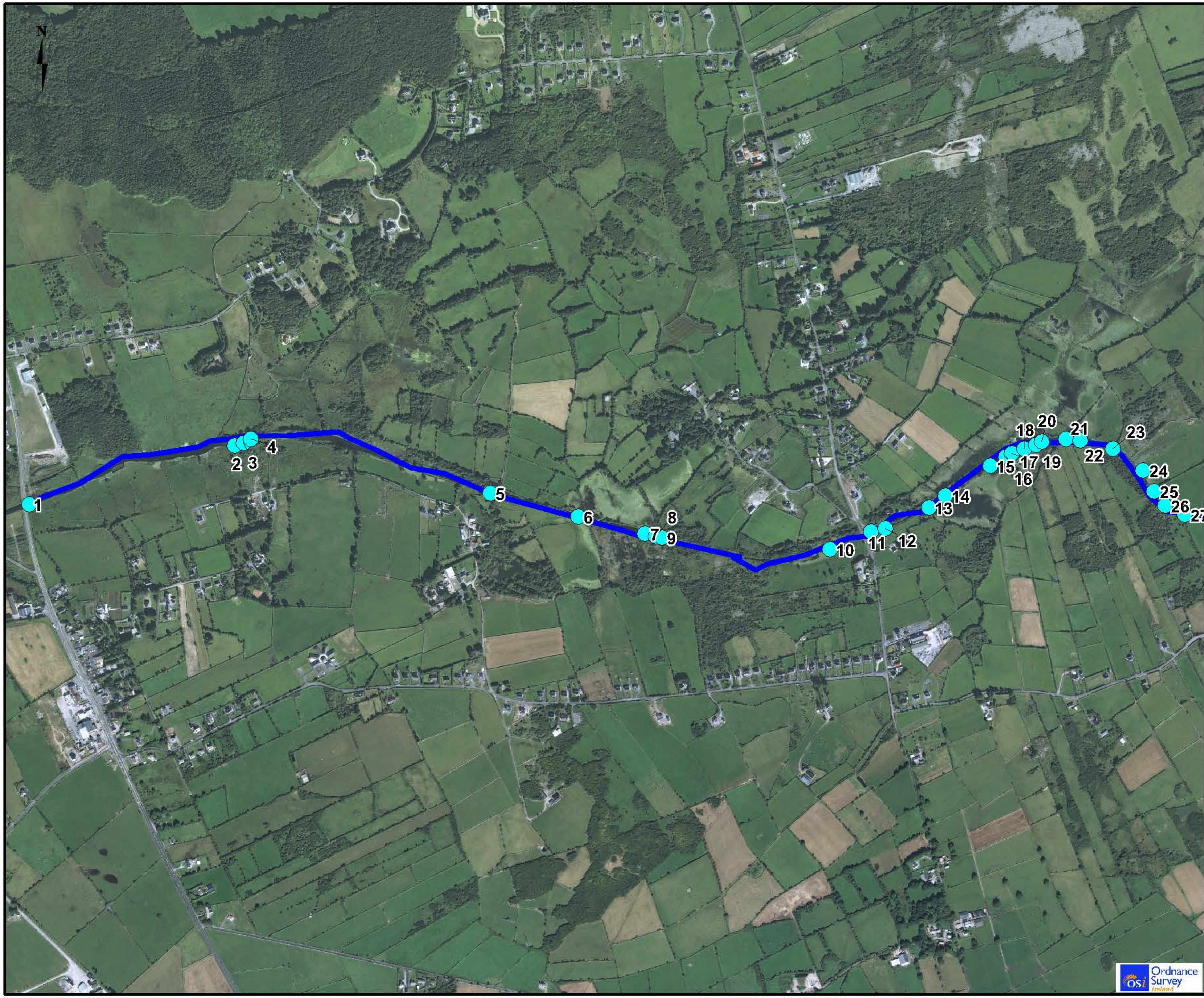
16	along the left bank (Photo 8683). *Nuphar lutea* floating leaves with algae and *S. emersum* (submerged) just upstream (Photo 8684). The channel here has widened considerably since Pt 12 and Pt13.	
17, 18	Between these points, just below the wide pool (Pt 19), *S. emersum* was very common in a faster flow part of the channel, with *Apium* and occasional *O. fluviatilis / aquatic* in marginal, shoals.	
19	Here the channel is at its widest, forming a pond-like area. The left bank is marked by a cattle access drinking area while the right bank of the pool is formed by a broad crescent of *S. erectum* fronted by a band of floating *N. lutea* leaves (Photo 8685)	8685
20	This marks the downstream end of a large patch of coarse gravel where salmon redds have been observed lately by IFI officers (photo 8688). From this point upstream the gradient significantly along with faster flow and a general stepped type channel.	8688
21	Short scour pool / excavated pool at the end of a step weir, with another in the mid-ground (Photo 8691a).	8691a
22	Shallow run with algae and moss on bed of small angular cobbles – heavy or light cover depending on shading (Photos 8703a, 8702a); substrate fairly embedded in most places.	8702a 8703a
23	Break-point in slope where a shallow glide, glide/run upstream, drops into a riffle/cascade-type stretch downstream (Photo 8693)	8693
24	Small cascade which heads the glide upstream from Pt 23. Glide in question with large cobble/boulder substrate with low plant cover – salmonids observed.	
25	Step/weir with scour pool below	
26, 27	Shallower step weir – short glide/run sequences heading upstream toward the bottom of the glide which begins downstream from Rinn Bridge. In these areas the channel is constricted between short rock/block banks and the distance between weirs shortens with increases in gradient –the substrate appears to be fairly embedded in places and with the degree of plant cover determined in large part by the amount of bank side shade (Photos 8694, 8701)	8694, 8701
28	The downstream end of the run/riffle which began upstream of Rinn Bridge (Pt 30) and the upstream end of a glide which continues for some distance downstream from this point.	
29	Kick-sample point – photo is a view upstream to the bridge	8673
30, 31' 32	This point marks the top of a run/riffle (quite torrential in places) which continues downstream and under Rinn Bridge (Photo 8863) and the downstream end of a glide which continues upstream toward the Rahasane turlough (Photo 8662). The downstream stretch of the latter, (i.e. between Pt 30 and Pt 31) marks a shallower, faster flowing stretch (0.3-0.4m) with small cobble and scattered boulder (maerl-encrusted) and gravel substrate, which is covered in a moderately dense growth of filamentous green alga and some moss (Photo 8665). Continuing upstream the flow slackens and deepens (around Pt 32 and upstream) and due to shade, depth, and slacker flow, alga covers drops off; there is also more bare bedrock evident in this stretch also (Photo 8669). 0+ salmonids were observed in the run stretch both upstream and downstream of Rinn Bridge, crayfish were noted in the transition area from glide upstream to run downstream, while numerous 1+ salmonids were noted in the linear pools (rock cut / excavated) within the glide area some of which were up to about 1m in depth. The long stretch between Pt 32 upstream to Pt 33 wasn't surveyed due to access difficulties. However, we can fairly confidently assume that in the main it will	8662 8663 8665 8669

	comprise shallow glide stretches interspersed by occasional much shorter riffle/runs below short step weirs. The substrate will comprise mainly cobble with low plant cover (due to dense shade) and a scarcity of finer bed material	
33	Moderately fast flowing and shallow (0.3-0.5m) glide over boulder, cobble and 'maerl sand/ fine gravel (8740). Up to 25% moss cover. Weir drop about 30m farther downstream (8741).	8740 8741
34	Upstream end of the extensive glide which forms the habitat of the outlet channel of the Dunkellin River from the Rahasane Turlough (deep, very slack flow, boulder substrate)	8738 8739
35	Rahasane Turlough main drainage channel toward the downstream end of the turlough – photo taken during a period of below mean annual flow (8736). This is lined by a low berm along its margins formed by the excavated spoil (8737). Very slack imperceptible flow, with dense marginal growths of low submerged/ emergents (*Rorippa nasturtium-aquaticum*, *Berula* (?), *Myosotis scorpioides*, *Callitriche* sp. and floating/ submerged *Nuphar lutea*, *Oenanthe fluviatile/aquatica*. Net sweeps through the marginal vegetation uncovered numerous juvenile crayfish (*Austropotamobius pallipes*), *Sigara* sp/spp, water beetles, molluscs incl. *Lymnaea stagnalis.*	8736 8737
36	Craughwell River just upstream of the Aggard stream confluence. Mixed, cobble, gravel and boulder run, with heavy *Ranunculus* cover (0.3-0.4m deep). Appears to be good spawning habitat in places.	8706
37	Downstream swifter flow end of glide which leads into run described at Pt36, banks (*Ranunculus* still prominent in-stream, with *S. erectum, Iris. pseudacorus, Valeriana officinalis* and nettle on the banks.	8708
37a	End of short run downstream from Point 38 above	
38	Short weir/cascade (Photo 8711) with moss and *Vaucheria* on boulders - leading down to 30/50m run (Photo 8712) which ends at Pt37a and continues into glide mentioned at Pt 37.	8711 8712
39	Top end of glide with run downstream at Pt 37a-38 (Photo 8713)	8713
39a	Weir/cascade in run	
40	Deep glide run (up to 0.8m deep) with large maerl-covered boulder and cobble – heavily shaded	
41	Deep holding stretch with pool	
41a	Cascade/weir in run	
42	Upper end of runs, steps, cascade/pools	
43	Deep pool at head of glide	
44	Top of glide and end of short turbulent cascade	8717
45	Turbulent run/cascade with varied boulder, cobble and gravel substrate, good moss / algal cover, leading downstream to slower deeper water at Pts 43/42.	8651
46	Top of shallow run – good plant cover finer substrate (gravels and small stones) in addition to bedrock and coarser elements - excellent salmonids juvenile habitat	
47	Downstream end of glide from upstream of railway bridge which was interrupted at the bridge by short riffle/run (~20m) - continues downstream to cascade/shute and as run/glide, much boulder substrate.	
48	Short (~20m) riffle, transitioning to glide below railway bridge – cobble with moss cover.	
49	Downstream end of riffle/run beginning at old stone arch Craughwell Bridge, which merges into deep boulder/bedrock glide – silted in places - (>1m deep in places) which continues downstream through the Railway Bridge (8721). All heavily shaded in run. Liverwort on some substrate.	8721
50	Head of riffle/run just below stone arch bridge (Photo 8719). Substrate of small	8718

	cobble, gravel and maerl sand (Photo 8719). *Vaucheria* common on substrate. Similar substrate upstream to N6 bridge but deeper and slower flow.	8719
51	Craughwell By-pass channel - Dry	Photo
52	Long glide upstream of N6 Bridge, boulder & cobble substrate in slack flow. This continues upstream to Pt 55, where another gradient breakpoint begins with steeper bed levels upstream and consequently faster turbulent flows and better juvenile salmonids habitat. These upstream stretches are however, heavily shaded also.	8841
53	Glide u/s N6 bridge continued	8820
54	Downstream outlet from overflow pond created when river is in high flow (8824) – the glide at Pt 52 and 54 continues upstream from here (8820) with emergent macrophytes along both banks including, *S. erectum*, *Schoenoplectus lacustris* and *Phalaris.*	8820 8824
55	Gradient breakpoint at head of long glide – cattle access point left bank	8829
56	Downstream end of riffle run where channel upstream has narrowed. Heavy shade from banks.	8830
57	Shaded run (~0.4m deep at margin)	8833
58	Torrential flow / run over coarse substrate – good nursery area, although heavily shaded.	8837

Target Note Positions in Irish National Grid

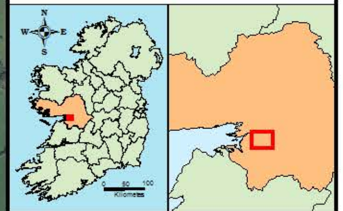
Point	East	North	Point	East	North	Point	East	North
1	141842	218502	**22**	144813	218682	**41**	150496	219751
2	142424	218667	**23**	144906	218658	**41a**	150513	219770
3	142449	218674	**24**	144991	218598	**42**	150535	219804
4	142469	218685	**25**	145021	218538	**43**	150667	219856
5	143145	218533	**26**	145052	218498	**44**	150675	219861
6	143394	218467	**27**	145108	218472	**45**	150699	219863
7	143582	218418	**28**	145422	218407	**46**	150732	219878
8	143613	218412	**29**	145456	218404	**47**	150756	219892
9	143630	218408	**30**	145609	218412	**48**	150840	219915
10	144106	218375	**31**	145668	218453	**49**	150990	219939
11	144222	218424	**32**	145671	218469	**50**	151057	219940
12	144263	218434	**33**	146022	218748	**51**	151062	220053
13	144385	218493	**34**	146174	218799	**52**	151105	219936
14	144432	218525	**35**	146205	218825	**53**	151201	219968
15	144559	218610	**36**	150151	219600	**54**	151220	219961
16	144603	218637	**37**	150159	219617	**55**	151321	120014
17	144619	218645	**37a**	150273	219664	**56**	151337	120018
18	144655	218658	**38**	150293	219671	**57**	151481	120000
19	144687	218670	**39**	150365	219688	**58**	151557	119947
20	144704	218679	**39a**	150421	219703			
21	144772	218685	**40**	150439	219715			



Legend

Dunkellin River, Aggard Stream & Monksfield River Study Section

Aquatic Target Notes



Client

Galway County Council

Project

Dunkellin River and Aggard Stream Flood Relief Scheme

Title

Aquatic Target Note Locations

Figure 1 of 3

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Drawn by: DM		Project No. MGE0260	
Checked by: MW		File Ref. MGE0260MI0016	
Approved by: WM			
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Date: October 2014		MI0016	F01

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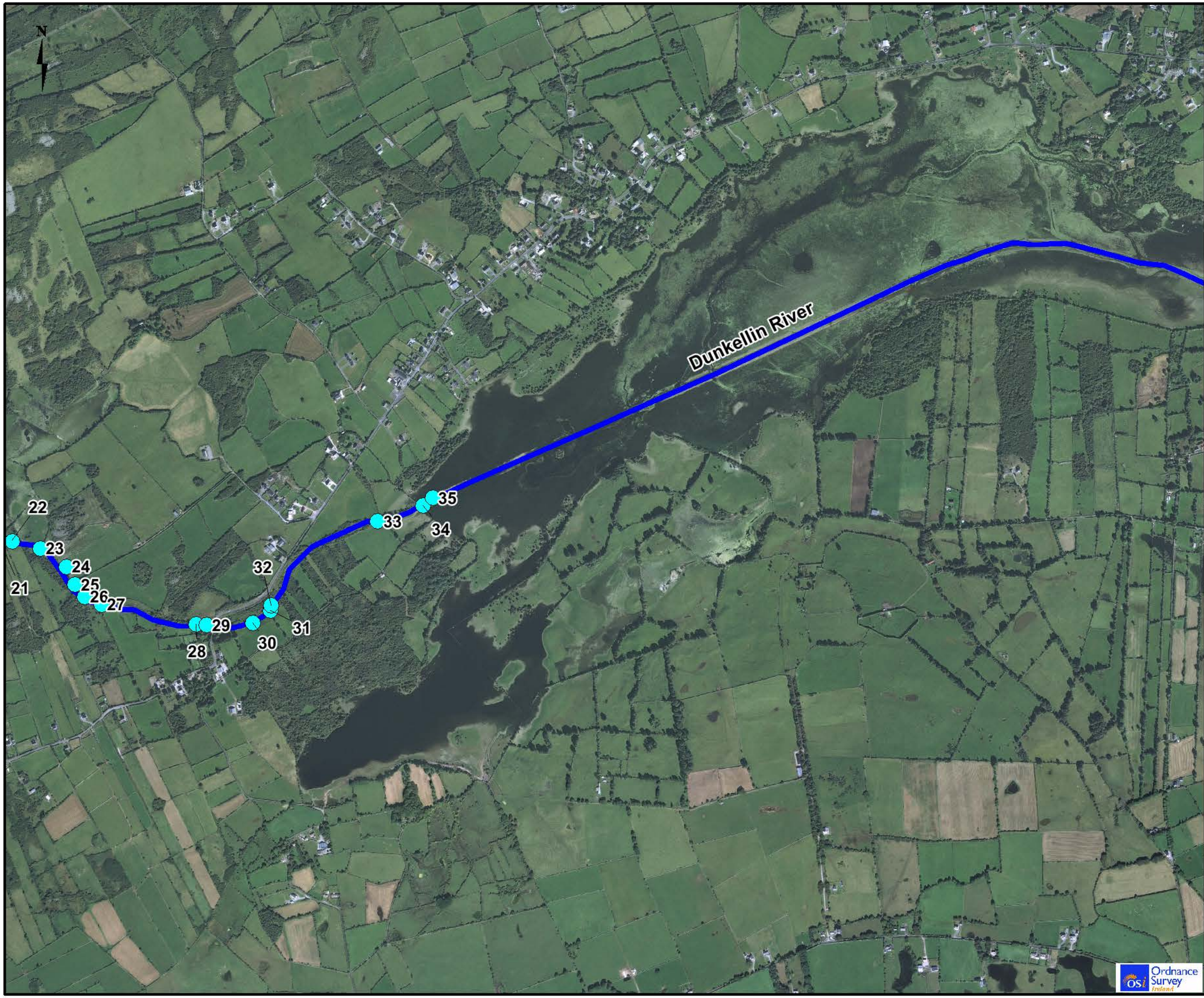
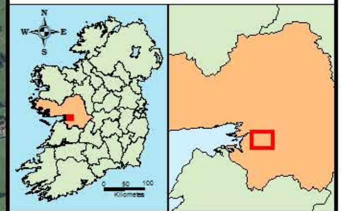


Legend

Dunkellin River, Aggard Stream & Monksfield River Study Section

Aquatic Target Notes



Client

Galway County Council

Project

Dunkellin River and Aggard Stream Flood Relief Scheme

Title

Aquatic Target Note Locations

Figure 2 of 3

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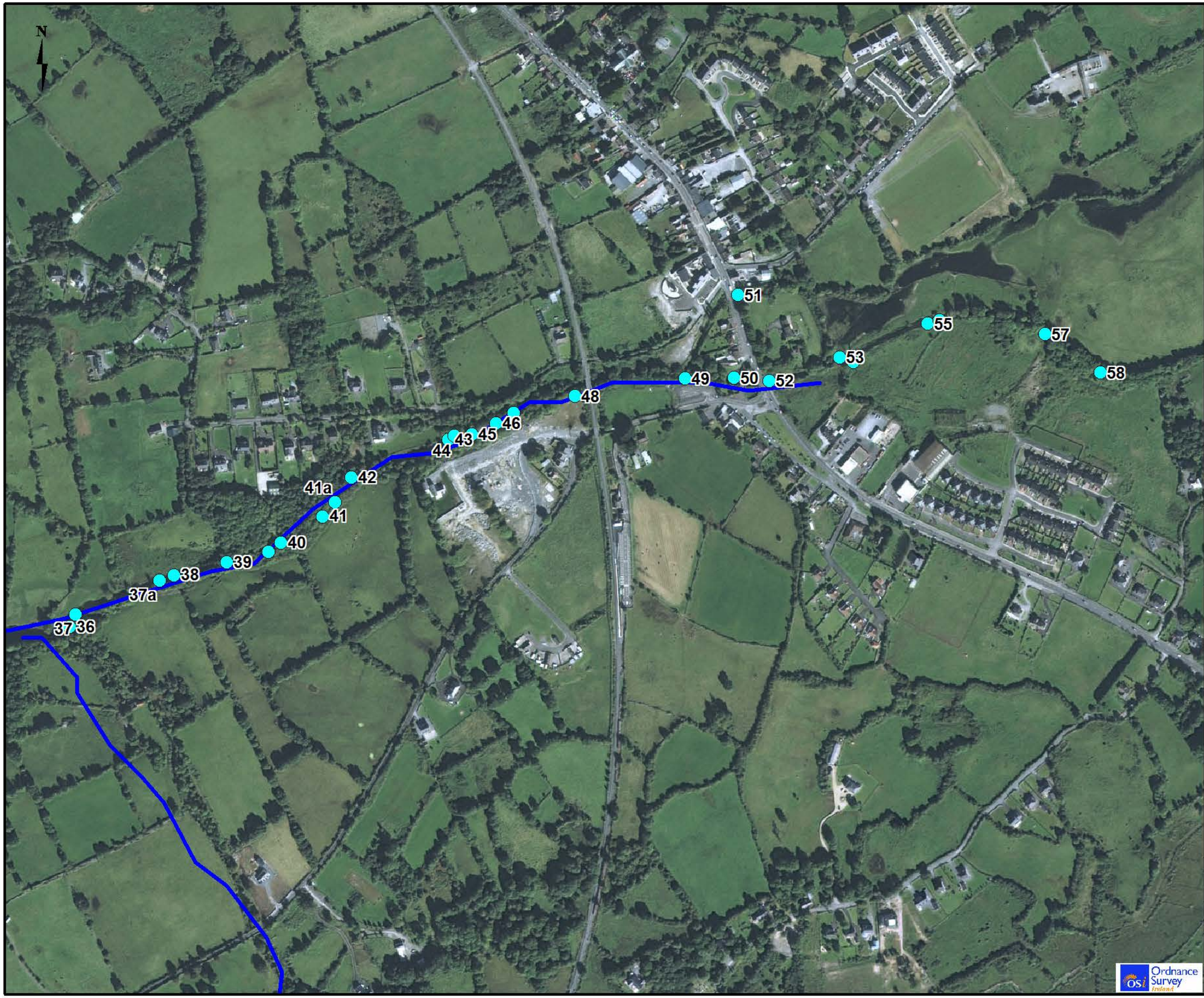

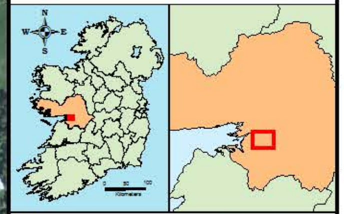

Legend

Dunkellin River, Aggard Stream & Monksfield River Study Section

Aquatic Target Notes

Client

Galway County Council

Project

Dunkellin River and Aggard Stream Flood Relief Scheme

Title

Aquatic Target Note Locations

Figure 3 of 3

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Approved by: WM			
Scale:	1:7,000@A4	**Drawing No.**	**Rev.**
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C3 Photographs

Table C3.1 - Site Photographs

KILCOLGAN N18 BRIDGE TO KILLEELY BEG BRIDGE

Plate 1: Broad glide upstream of Kilcolgan N18 Bridge on the Dunkellin River -view upstream (Point 1)
(21-7-2011)

Plate 2: Just upstream of Kilcolgan Bridge showing submerged macrophytes in shallow glide / run. (21-07-2011)

Plate 3: Cascade / turbulent run ~500m upstream of Kilcolgan bridge.

Plate 4: Shallow glide/run upstream of P3.

Plate 5: Glide-pool just downstream of the point where the channel narrows (9/8/2011)

Plate 6: Short step / weir at the head of a run, downstream of the salmon counter at Killeely Beg Bridge (21-7-2011)

Plate 7: Glide upstream of step / weir shown in Plate 4 above. – view upstream toward salmon counter below Killeely Bridge. (21-7-2011)

Plate 8: Salmon counter below Killeely Bridge – view downstream. (20-7-2011)

.

Plate 9: View upstream from approx. 100m D/S Killeely Beg Bridge showing true left bank with extensive rip-rap reinforcement and right bank of rock cut with crevices that would provide good refuges for crayfish (20-7-2011)

Plate 10: Typical substrates downstream of the Killeely Beg Bridge and salmon counter – with sculpted bedrock dominant with some scattered boulder with limited refuge availability for crayfish except in banks (20-7-2011)

<u>KILLEELY BEG BRIDGE TO DUNKELLIN BRIDGE.</u>

Plate 11: View US from approx. 50m US of Killeely Beg Bridge showing step-run-glide sequence and block armour on left bank (20-7-2011)

Plate 12: Typical substrates just upstream of Killeely Beg Bridge (20-7-2011).

Plate 13: Broad shallow pool section at the head of a long glide upstream from Killeely Bridge showing emergent macrophytes on right bank. (21-7-2011).

Plate 14: Turbulence at drop at the downstream end of a long shallow run in Point15. View downstream over short deep pool and shallow pool at Point13 downstream (21-7-2011).

Plate 15: View upstream from Point 14 (above) along a long run heading up towards Dunkellin Bridge (21-7-2011)

Plate 16: Looking downstream over shallow glide situated 80-90m below Dunkellin Bridge (21-7-2011)

Plate 17: View upstream towards Dunkellin Bridge over shallow run / glide (20-7-2011).

Plate 18: Shallow run / glide situated 50-60m below Dunkellin Bridge where salmon redds have been recorded by IFI (20-7-2011).

<u>DUNKELLIN BRIDGE TO RINN BRIDGE.</u>

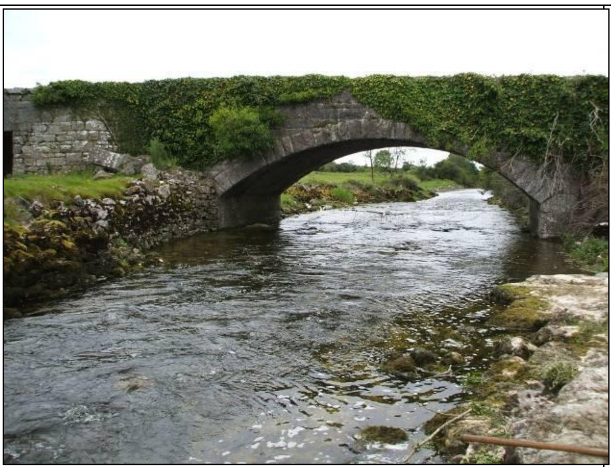


Plate 19: View downstream through Dunkellin Bridge showing riffle/ run (21-7-2011)	**Plate 20**: Shallow, narrow glide upstream of Dunkellin Bridge- note coarse substrate with rock cut banks on true right and rip-rap reinforcement on true left(21-7-2011)

	
Plate 21: View upstream of slightly wider glide with marginal emergent macrophytes, upstream of canalised stretch shown in Point 20 (21-7-2011).	**Plate 22: L**arge shallow pool (background) at the upstream end of the glide stretch shown in Plate 21, margin fringed with *Sparganium erectum* and Yellow Water-lily (21-7-2011).

	
Plate 23: First riffle upstream of Dunkellin Bridge, just upstream of pool shown in Plate 22. Crayfish were captured here within 2 minutes of manual searching (21-7-2011).	**Plate 24**: Close-up of coarse gravel used in salmon spawning situated at riffle shown in Plate 23 (21-7-2011).

Plate 25: More typical, longer segments of glide, step run sequence (Point 23). (21-7-2011)

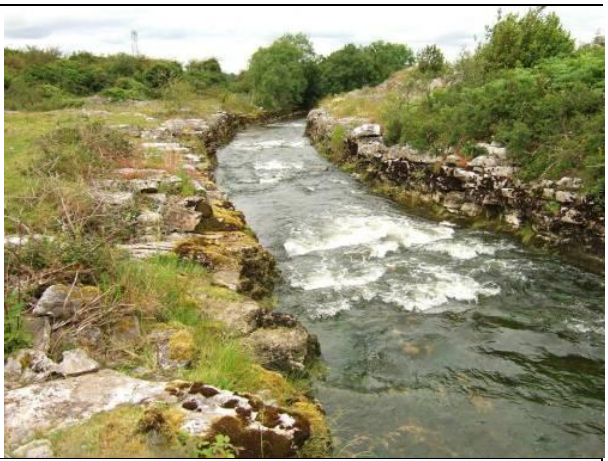


Plate 26: Much more closely spaced step/weir/ run sequences near Point 27 between Dunkellin Bridge and Rinn Bridge. (21-7-2011)

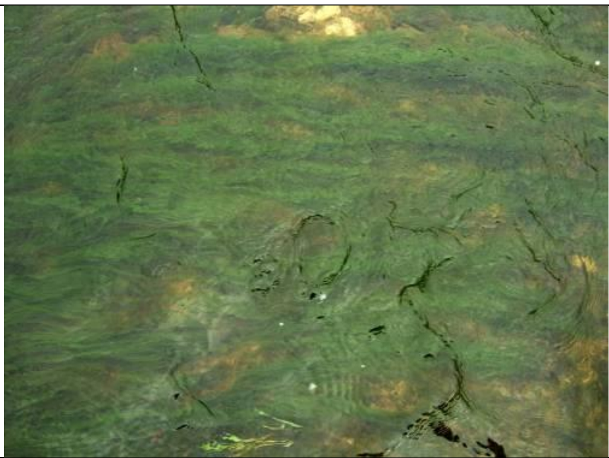


Plate 27: Example of heavy algal cover on substrate of shallow run near Point 22. (21-7-2011)

Plate 28: View upstream to Rinn Bridge at and of run which leads into long glide downstream. (21-7-2011)

<u>RINN BRIDGE TO RATHASANE TURLOUGH.</u>

Plate 29: View downstream to Rinn Bridge showing shallow run/riffle at, and upstream of, the bridge (21/7/2011).

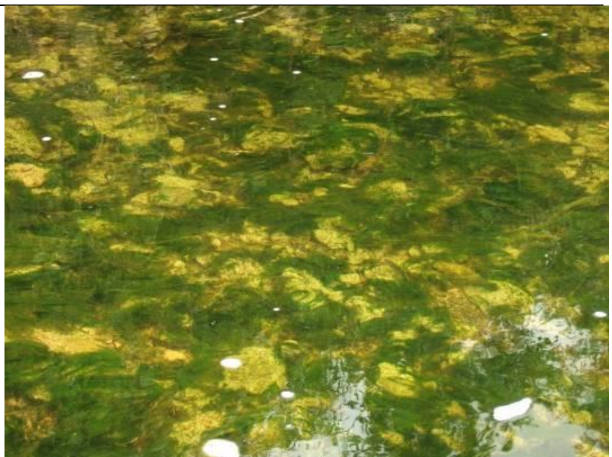


Plate 30: Moderately heavy algal cover on substrate in un-shaded shallow run upstream of Rinn Bridge (21-7-2011)


Plate 31: View of long run downstream from Point 32 toward Rinn Bridge. (21-7-2011).

Plate 32: View upstream of long glide upstream from Point 32 (21-7-2011).


Plate 33: Shallow long glide downstream of Rahasane Turlough at Pt 33 – view upstream (21-7-2011).

Plate 34: View of deeper glide at downstream exit from Rahasane Turlough to Dunkellin River – view downstream (21-7-2011).


Plate 35: Rahasane Turlough drainage channel – view upstream from just above exit to Dunkellin River (21-7-2011). White-clawed crayfish hatchlings were caught in pond sweeps among submerged macrophytes.

Plate 36: Open water adjoining the Rahasane Turlough drainage channel near the downstream end (21-7-2011).

Plate 37: Small white-clawed crayfish captured in kick-sample at Rinn Bridge. Crayfish were present throughout the section between Rinn Bridge and Rathasane Turlough.

Plate 38: Juvenile white-clawed crayfish captured in aquatic weed sweeps in the Rahasane Turlough drainage channel.

AGGARD STREAM CONFLUENCE TO UPSTREAM OF CRAUGHWELL.

Plate 39: View US on Craughwell River just US of Aggard Stream confluence – note heavy crop of mid-channel *Ranunculus*. Crayfish were utilising marginal macrophytes, boulders/cobbles and rip-rap reinforcement on far bank (20-7-2011).

Plate 40: First glide upstream of Aggard Stream confluence – view upstream. Crayfish were present in marginal macrophytes (21-7-2011).

Plate 41: Short, step/weir – run sequence at Point 38 (21-7-2011)

Plate 42: Middle lengthy glide between Aggard Stream confluence and Craughwell US from Point 42- view US (21-7-2011)

Plate 43: Short cascade leading into a run near Point 45. View US (20-7-2011). Crayfish found under boulders at margins in this habitat.

Plate 44: View US over shallow riffle /run downstream from the masonry railway bridge (Point 48) (20-7-2011).

Plate 45: Riffle/run/glide downstream of railway bridge. Optimal crayfish habitat with submerged tree-roots and boulder/cobble substrates. Note the turbidity, evident in Craughwell R. but not below the turlough on the Dunkellin R. (20-7-2011).

Plate 46: Shallow riffle /run downstream from the old masonry pedestrian bridge - view DS (20-7-2011).

Plate 47: Close-up of substrate in Plate 46 – note the clumps of filamentous green alga (*Vaucheria* sp.) and pockets of maerl sand between small cobbles and gravel (21-7-2011).

Plate 48: View upstream over shallow glide/run towards old bridge at Craughwell, with the N6 Bridge visible beyond. Crayfish were abundant under boulder/cobble in this stretch.

Plate 49: View of long glide upstream of R446 Bridge in Craughwell, this is a popular angling stretch. (21-7-2011).

Plate 50: Craughwell River 250m US of Craughwell. Point 53 (16-8-2011)

Plate 51: Cattle access point at upstream end (Point 55) of glide shown in Plate 49 and 50. Potential spawning gravels observed here. (16-8-2011)

Plate 52: View US of Craughwell River at Point 56 where the river is more turbulent (at the head of riffle shown in Plate 51. (16-8-2011)

Plate 53: Less turbulent water at Point 57. (16-8-2011)

Plate 54: View DS of turbulent run at Point 58 (16-8-2011).

	
Plate 55: Close up of turbulence at Point 58. (16-8-2011)	**Plate 56:** View DS from bridge at Caheradangan c.1.5km US of Craughwell. Crayfish habitat was optimal and they appear to be present in at least moderate abundance.

AGGARD STREAM

	
Plate 57: Riffle/Run Below Aggard Bridge (AG1) (8-1-2012)	**Plate 58:** Run Below Aggard Bridge (AG2) (8-1-2012)

	
Plate 59: Run just below Aggard Bridge (AG3) (8-1-2012)	**Plate 60**: Just u/s Aggard Bridge – view u/s to staff gauge on left bank (AG4) (8-1-2012)

Plate 61: View d/s from AG5 - 'shoulders' of channel on both banks inundated – heavy *Ranunculus* in centre (8-1-2012)

Plate 62: View d/s from AG6 - left foreground is toe of stepped drainage embankment (8-1-2012)

Plate 63: View u/s from AG7 (8-1-2012)

Plate 64: View u/s at AG8 – cattle access point (8-1-2012)

Plate 65: Aggard Stream at AG8 – view u/s from cattle access point (8-1-2012)

Plate 66: AG 9 – *Glyceria* covered 'shoulder' just u/s AG8 (view u/s) – substrate of silty sand (8-1-2012)

Plate 67: Metal footbridge at AG 10 – view u/s (8-1-2012)

Plate 68: View u/s from footbridge at AG10) (8-1-2012)

Plate 69: View d/s from farm road bridge at AG11 (8-1-2012)

Plate 70: View d/s from AG12 to bridge at AG11 (8-1-2012)

Plate 71: View u/s at AG13 -note swifter flows and heavy *Ranunculus* and open left bank (8-1-2012)

Plate 72: View d/s at AG13 -close-up of channel (8-1-2012)

Plate 73: View u/s at AG15 (8-1-2012)

Plate 74: View u/s at AG16 – deeper, narrower channel (8-1-2012)

Plate 75: View u/s of (possible summer) cattle fording point – AG17 (8-1-2012)

Plate 76: View u/s at AG18 (8-1-2012)

Plate 77: View d/s at AG19 - Fast glide with *Ranunculus* (8-1-2012)

Plate 78: View d/s - shallow cattle access point at AG20 (8-1-2012)

Plate 79: View u/s at AG21 – d/s end of riffle/run (8-1-2012)

Plate 80: **AG22 -** view d/s from Byroad bridge (8-1-2012)

Plate 81: View downstream to by-road bridge at AG23 - shallow run/riffle habitat with much *Ranunculus* (8-1-2012)

Plate 82: View upstream at AG24 - note narrowing of channel and steepness of banks (8-1-2012)

Plate 83: Clay-lined bottom / pool at AG26 (8-1-2012)

Plate 84: main branch of Aggard flowing from the east (view u/s) (8-1-2012)

	
Plate 85: View u/s of southern branch at AG27 (upstream of confluence of eastern branch) - cutaway bog on both banks (8-1-2012)	**Plate 86:** south-western branch (main branch undergoing culverting) – view upstream at AG28 (i.e. towards SW) (8-1-2012)

C4 Macroinvertebrates

Table C4.1 - Aquatic Macroinvertebrates within the Craughwell and Dunkellin River and the Aggard Stream

TAXA	EPA Quality Category	SITE		
		Craughwell R.	Dunkellin R.	Aggard Stream
Irish Grid Reference		M 51039 19935	M 45496 18387	M 50385 19237
MAY FLIES (Ephemeroptera)				
Heptageniidae:	A	*		
Heptagenia sulphurea		5		
Ecdyonurus dispar		8		
Rhithrogena sp.		1		
Baetis muticus	B	3	15	3
Baetis rhodani	C	51	100+	300+
Seratella ignita	C	21	9	35
STONE FLIES (Plecoptera)				
Protonemoura spp.	A	2	2	
Leuctra spp.	B	100+	37	3
CADDIS FLIES (Trichoptera)				
Lepidostoma hirtum	B	1		
Rhyacophila dorsalis	C	23	5	2
Hydropsychidae	C	37	88	1
Glossosomatidae	B	1		7
Polycentropidae	C	*	*	
Plectrocnemia sp.		1		
Polycentropus flavomaculatus		2	12	
Wormaldia subnigra	C	28		
Limnephilidae:	C	*		
Anabolia nervosa		1		
TRUE FLIES (Diptera)				
Chironomidae	C	50	37	16
Simuliidae	C	87		75
Tipulidae	C	1		16
BEETLES (Coleoptera)				
Hydraenidae	C		1	
Dytiscidae	C	1		
Elmidae	C	32	54	44
F/W SHRIMPS (Crustacea)				
Gammarus sp.	C	96	34	300+
Austropotamobius pallipes	C	3	2	3
Asellus aquaticus	D			5
SNAILS (Mollusca)				
Bithynia tentaculata	C		2	
Ancyclus fluviatilis	C	2		
Planorbis spp.	C		5	12
Potomapyrgus spp.	C	58	5	38
Physa sp.	**C**			1

TAXA	EPA Quality Category	SITE		
		Craughwell R.	Dunkellin R.	Aggard Stream
Valvata macrostoma	**C**			5
Lymnaea stagnalis	D		2	
Lymnaea peregra	D		7	6
WORMS (Annelida)				
Oligochaetae	E	20	23	3
EPA Q Value		**Q4**	**Q3-4**	**Q3**
Total BMWP Score		131	86	86
ASPT		6.2	5.4	4.78
%EPT		45%	61%	40%

C5 Waterbeetle Records

Table C5.1: Existing waterbeetle records from Rahasane Turlough, H15, South East Galway, courtesy of Dr A. O'Connor, NPWS.

Species	Grid ref.	Record Date	Year	Collector
Agabus nebulosus	M474186	24-Aug-04	2004	Waldron, Mr F.
Agabus sturmii	M474186	24-Aug-04	2004	Waldron, Mr F.
Cercyon tristis	M474186	12-Nov-03	2003	Waldron, Mr F.
Hygrotus impressopunctatus	M474186	12-Nov-03	2003	Waldron, Mr F.
Hygrotus impressopunctatus	M474186	24-Aug-04	2004	Waldron, Mr F.
Elmis aenea	M474186	12-Nov-03	2003	Waldron, Mr F.
Elmis aenea	M474186	24-Aug-04	2004	Waldron, Mr F.
Graptodytes bilineatus	M474186	24-Aug-04	2004	Waldron, Mr F.
Haliplus sibiricus	M474186	12-Nov-03	2003	Waldron, Mr F.
Helophorus brevipalpis	M474186	12-Nov-03	2003	Waldron, Mr F.
Helophorus brevipalpis	M474186	24-Aug-04	2004	Waldron, Mr F.
Helophorus minutus	M474186	12-Nov-03	2003	Waldron, Mr F.
Helophorus minutus	M474186	24-Aug-04	2004	Waldron, Mr F.
Hydrobius fuscipes	M474186	12-Nov-03	2003	Waldron, Mr F.
Hydrobius fuscipes	M474186	24-Aug-04	2004	Waldron, Mr F.
Hydroporus palustris	M474186	12-Nov-03	2003	Waldron, Mr F.
Hydroporus palustris	M474186	24-Aug-04	2004	Waldron, Mr F.
Hydroporus planus	M474186	12-Nov-03	2003	Waldron, Mr F.
Hydroporus planus	M474186	24-Aug-04	2004	Waldron, Mr F.
Hygrotus inaequalis	M474186	12-Nov-03	2003	Waldron, Mr F.
Hygrotus inaequalis	M474186	24-Aug-04	2004	Waldron, Mr F.
Hygrotus quinquelineatus	M474186	12-Nov-03	2003	Waldron, Mr F.
Hygrotus quinquelineatus	M474186	24-Aug-04	2004	Waldron, Mr F.
Megasternum concinnum	M474186	12-Nov-03	2003	Waldron, Mr F.
Noterus crassicornis	M474186	24-Aug-04	2004	Waldron, Mr F.
Agabus bipustulatus	M4820	12-Jun-89	1989	Bilton, Dr D.T
Agabus nebulosus	M4820	12-Jun-89	1989	Bilton, Dr D.T
Helophorus aequalis	M4820	12-Jun-89	1989	Bilton, Dr D.T
Helophorus brevipalpis	M4820	12-Jun-89	1989	Bilton, Dr D.T
Helophorus grandis	M4820	12-Jun-89	1989	Bilton, Dr D.T
Hydroporus palustris	M4820	12-Jun-89	1989	Bilton, Dr D.T
Hydroporus planus	M4820	12-Jun-89	1989	Bilton, Dr D.T
Hygrotus quinquelineatus	M4820	12-Jun-89	1989	Bilton, Dr D.T
Ilybius ater	M4820	12-Jun-89	1989	Bilton, Dr D.T
Ilybius fuliginosus	M4820	12-Jun-89	1989	Bilton, Dr D.T
Laccophilus minutus	M4820	12-Jun-89	1989	Bilton, Dr D.T

Species	Grid ref.	Record Date	Year	Collector

Helophorus brevipalpis	~	~	2001	Dr A. O'Connor
Hygrotus quinquelineatus	~	~	2001	Dr A. O'Connor
Helophorus brevipalpis	~	~	2002	Dr A. O'Connor
Helophorus grandis	~	~	2002	Dr A. O'Connor
Helophorus minutus	~	~	2002	Dr A. O'Connor
Agabus nebulosus	~	~	2002	Dr A. O'Connor
Coelambus impressopunctatus	~	~	2002	Dr A. O'Connor
Haliplus obliquus	~	~	2002	Dr A. O'Connor
Helophorus minutus	~	~	2002	Dr A. O'Connor
Helophorus brevipalpis	~	~	2002	Dr A. O'Connor
Hydroporus planus	~	~	2002	Dr A. O'Connor
Hydroporus palustris	~	~	2002	Dr A. O'Connor
Hygrotus quinquelineatus	~	~	2002	Dr A. O'Connor
Laccophilus minutus	~	~	2002	Dr A. O'Connor

C6 White-clawed Crayfish surveys and assessment criteria

Table C6.1: White clawed Crayfish surveys and assessment criteria Dunkellin River

Location	Habitat description of survey 'patches' and methods employed.	Location	Site Photograph	Crayfish abundance (CPUE) and habitat assessment
N18 Bridge	Glide run with boulders and finer substrates with dense coverage of submerged and emergent aquatic macrophtyes (e.g., *Apium*, *Berula* and *Sparganium*).	M 41842 18502		**CPUE = 0** Absent or undetected. **Sub-optimal.**
Between N18 Bridge and Kileely Bridge	30m stretch of boulder/cobble overlaying silty gravels at river margin, with a lot of moss and liverwort. 15min manual search of refuges.	M 42469 18685		**CPUE = 0** Absent or undetected. **Sub-optimal at mid-channel mainly owing to channel velocity. Optimal habitat at river margin.**
Kileely Beg Bridge	5 habitat patches (50 refuges) searched in 100m stretch (50m either side of bridge). Banks of un-mortared block armour reinforcement. Channel substrates largely bedrock with a few overlaying boulders.	U/S: M 43260 18497		**CPUE = 0** Absent or undetected. **Sub-optimal or Poor habitat for juveniles and adults mid-channel. Optimal habitat at river banks.**

Location	Habitat description of survey 'patches' and methods employed.	Location	Site Photograph	Crayfish abundance (CPUE) and habitat assessment
		D/S: M 43098 18550	 .	
Dunkellin Bridge	5 habitat patches (50 refuges) searched in 100m stretch (50m either side of the bridge). U/S - Banks of cut-stone and un-mortared block armour reinforcement. Channel substrates of boulder and cobble with very little instream vegetation and glide/run flow. D/S riffle/run into wider section of glide over boulder/cobble + finer substrates.	U/S: M 44577 18590 D/S:	 	**CPUE = 0** Absent or undetected **Optimal + some sub-optimal habitat for juveniles and adults mid-channel. Optimal habitat at river banks.**

Location	Habitat description of survey 'patches' and methods employed.	Location	Site Photograph	Crayfish abundance (CPUE) and habitat assessment
1st riffle U/S of Dunkellin Bridge	Cobble/gravel riffle with small boulders. 10min manual presence/absence search.	M 44733 18676		CPUE = N/A **Crayfish Present** (Total of 4 adults found under larger stones) **Optimal habitat.**
c.100m D/S Rinn Bridge	15 min manual search under boulders at accessible margins. Long glide – primarily bedrock with small and large boulders and no in-stream plant cover. A lot of.	M 45394 18457		**CPUE = approx. 1 per 10 refuges** Moderate abundance **Generally sub-optimal habitat. Many potential refuges were inaccessible so the CPUE may be an underestimate.**
Rinn Bridge	5 habitat patches (50 refuges) searched in approx. 80m stretch (40m either side of the bridge). Shallow riffle/run over cobble with moderate coverage of filamentous algae. Banks generally of cut stone.	M 45496 18387		**CPUE = 2 per 10 refuges** Moderate abundance **Optimal habitat. Both juvenile and adult crayfish present.**

Location	Habitat description of survey 'patches' and methods employed.	Location	Site Photograph	Crayfish abundance (CPUE) and habitat assessment
Rahasane Turlough	15minutes weed sweep amongst dense aquatic vegetation.	M 46174 18799		**CPUE = N/A** Crayfish present. A number of small juveniles captured in weed sweeps. Optimal habitat for juveniles. Also suitable for adults, though not optimal.

Table 2: CRAUGHWELL RIVER

Location	Habitat description of survey 'patches' and methods employed.	Location	Site Photograph	Crayfish abundance (CPUE) and habitat assessment
Craughwell River just U/S Aggard Stream confluence		M 50159 19617		**CPUE = N/A** **Crayfish present.** **Optimal habitat.**

Location	Habitat description of survey 'patches' and methods employed.	Location	Site Photograph	Crayfish abundance (CPUE) and habitat assessment
Craughwell River between Aggard confluence and Rail Bridge	Spot sampling.			**CPUE = N/A** **Crayfish present.** **Sub-optimal habitat.**
Craughwell River at Rail Bridge	Spot sampling.			**CPUE = N/A** Appears to be a moderate-high abundance. Optimal habitat.
Craughwell River N6 Bridge/ Stone arch masonry Pedestrian Bridge	5 habitat patches (50 refuges) searched in 100m stretch (50m either side of the bridge).	M 51105 19930		**CPUE = 3 per 10 refuges:** High abundance. Optimal habitat.

Location	Habitat description of survey 'patches' and methods employed.	Location	Site Photograph	Crayfish abundance (CPUE) and habitat assessment
Craughwell River, c.1.5km U/S Craughwell.	15min manual search of refuges along margins. Boulder over gravel/sand. Water levels very high and coloured which limited efficacy.	M 52658 20044		**CPUE = N/A** **4 crayfish** **Crayfish present.** Optimal habitat.

Table 3: Crayfish habitat evaluation criteria

OPTIMAL	SUB-OPTIMAL	POOR
Boulders (>25 cm), stone or other material >	large cobbles (15–25 cm) >>	small cobble (6–15 cm)
Slow-flowing glides and pools (provided there are refuges) >	riffles >>	high-energy areas such as rapids (avoided).
Localised velocity of 0.1m s-1 or less >	less than 0.2m sec-1 >>	more than 0.2 m sec-1 (avoided).
Boulders or large cobbles in groups with crevices between them >	isolated large stones on smaller substrate such as pebble and gravel >>	a lot of small stone (small cobble and pebble).
Deep crevices in bedrock (can't usually search) >	partly flattened boulders and large cobbles >>	high-sided, rounded cobbles (more easily rolled in spates).
Underlying substrate of fine gravel/sand with some pebbles >	pebble and coarse gravel >>	Silt and clay.
Loose boulders	>>	deeply bedded boulders in a compacted bed (not accessible to crayfish).
Submerged refuges in stable banks (e.g. natural crevices, stone block reinforcement or stable, slightly undercut banks with overhanging vegetation, large tree roots >	refuges in the slow-flowing margins >	refuges in mid-channel (avoided especially if flow is a run or higher energy).
Margins with submerged and emergent	margins where adjacent banks have no	margins where adjacent earth banks are

aquatic vegetation and favourable bankside habitat >	scope for refuges (e.g. bare shallow slopes) >>	slumped and actively eroding.

APPENDIX D

Archaeology

D1 RMP Sites

RMP SITES WITHIN THE SURROUNDING AREA

RMP No.:	GA103-134
Townland:	Killeely More
Parish:	Killeely
Barony:	Dunkellin
NGR:	142672, 218628
Classification:	*Fulacht Fiadh*
Dist. from development:	To immediate south
Description:	In an area of low marshy ground on the south bank of Kilolgan River. A small stream flows to the north and west of the site. This site is represented by a grass covered mound sloping steeply on its eastern side and gradually on its western side. H *c*. 1m. The mound measures *c* 7.4m north–south by 9m east–west. Does not show classic horse shoe shape. Burnt stone noted beneath the sod.
Reference:	RMP File

RMP No.:	GA103-120001
Townland:	Dunkellin
Parish:	Killeely
Barony:	Dunkellin
NGR:	144030, 218279
Classification:	Deserted Village
Dist. from development:	To immediate south
Description:	The site consists of an extensive deserted settlement of uncertain date which is not marked on any editions of the OS maps. It is comprised of a number of rectangular house sites, cultivation plots, two lime kilns, a well and a boreen or street extending into 3 fields in the immediate area between Dunkellin castle and church. Field 1 contains a long rectangular house site, consisting of grass covered stone foundations. The settlement is undisciplined following no particular pattern. Three rectangular house sites are readily identifiable. The cultivation plots are also small and irregular. A date for the settlement is uncertain. It may post date the church and castle.
Reference:	RMP File

RMP No.:	GA103-120002
Townland:	Dunkellin
Parish:	Killeely
Barony:	Dunkellin
NGR:	144147, 218310
Classification:	Tower House
Dist. from	To immediate south

development:	
Description:	The castle is situated on a mound with a prominent view of the surrounding countryside. The castle is in an almost ruined state and only faint traces of the walls may be seen. One wall running north to south is 3m long, W 1.5m and H 0.4m. Faint traces of a wall running east–west adjoining the north–south wall may be seen. The mound is situated in the centre of a small square area with a bank and external ditch and in eastern sector faint traces of an external bank can be seen.
Reference:	RMP File

RMP No.:	GA103-120004
Townland:	Dunkellin
Parish:	Killeely
Barony:	Dunkellin
NGR:	144103, 218300
Classification:	Dovecote
Dist. from development:	To immediate south
Description:	This tower is situated in the middle of very overgrown countryside beside a river. It is a circular tower in a very ruinous condition. All that remains is a stone and earth covered stump. The pigeon tower could be part of the structures of the nearby castle.
Reference:	RMP File

RMP No.:	GA104-053
Townland:	Ballynamannin
Parish:	Ardrahan
Barony:	Dunkellin
NGR:	150473, 216697
Classification:	Enclosure
Dist. from development:	Immediately west of Aggard Stream
Description:	This site is situated to the west of a stream in an area of rolling pasture. It is a rectangular structure delimited by a very low bank composed of stone and soil. To the south is a fairly wide ditch. Outside this is an external bank. The interior is raised above the surrounding terrain. OPW Field Notes 1992: The enclosure is rectangular measuring 50m north–south by 30m east–west and is defined by a very low grassed over bank (Width 2m, Height 0.1m-0.15m). Its purpose or age cannot be determined from present remains.
Reference:	RMP File

RMP No.:	GA103-102, 001
Townland:	Castlegar
Parish:	Killeely
Barony:	Dunkellin

NGR:	144049, 218476
Classification:	Enclosure and Inauguration site
Dist. from development:	*c*. 25–60m north
Description:	In 1983 the fort referred to by McCaffrey could not be located. As well as this local inhabitants had no knowledge of one ever existing. Site stands on a south facing downslope overlooking the Dunkellin/Kilcolgan river to the south. Clearly visible are the castle a church also to the south. The general area is fertile pasture land. The diameter of the enclosure measured off the original 25" mapping is *c*. 120m north-east to south-west by 80m north–south. A modern house and shed are built in the eastern section of this enclosure close to the road. D shaped enclosure is defined by modern grass covered field banks.
Reference:	RMP File

RMP No.:	GA104-052, 001
Townland:	Ballynamannin
Parish:	Killora
Barony:	Dunkellin
NGR:	150525, 216955
Classification:	Ringfort and souterrain
Dist. from development:	*c*. 30m east of Aggard Stream
Description:	This multivallate ringfort is situated in an area of rolling pasture. To the northwest are the railway line and a stream. The interior is raised above the level of the surrounding land. It contains a Souterrain in the southeast and west quadrants. The one to the northwest was inaccessible. Otherwise no internal features. A modern field wall disturbs it in the southeast quadrant. This wall extends both north and south cutting through the 2nd and 3rd banks. Between the 2nd and 3rd bank is a wide shallow ditch. To the west the railway construction was the cause of destruction. This Souterrain is situated within the trivallate ringfort Ballynamannin 2. The souterrain's entrance lies 2m from the internal bank in the ringfort's southeast quadrant and the Souterrain has a NNW-SSE alignment. The monument is well constructed with 7/8 visible courses of well laid limestone boulders. It contains a small air vent *c*. 0.4m x 0.28m which can be noted at the ringfort's ground surface. Modern rubbish has been tipped into the monument. The roof is formed by 8 massive lintels averaging 1.8m wide. The chambers average width is 1.1m narrowing slightly at roof level.
Reference:	RMP File

RMP No.:	GA104-118
Townland:	Cloghroak
Parish:	Ardrahan
Barony:	Dunkellin
NGR:	149297, 214391

Classification:	Castle
Dist. from development:	*c*. 30m east of Aggard Stream
Description:	This tower house is situated on an outcrop of rock in undulating pastureland. It is sub-rectangular in plan and has a domestic range to the west of it as well as traces of a bawn wall to the west and north-west. The tower house survives to the third floor. The ground floor of tower house is entered via a doorway in the north wall. The main chamber has three windows, on each in the east, south and west walls. The first floor is reached 1.5m above the point at which the staircase stops starts spiralling. It is entered through a doorway in the eastern wall. Between the 1st and 2nd stories is a garde robe in the eastern wall. On the 2nd storey only the floor remains. J Fahey, DD. 'The History and Antiquities of the Diocese of Kilmacduagh' 1893, 244-245: "The Castle of Cloghroke stood about eight miles eastward of Kilcornan. It was the seat of an ancient and distinguished branch of the same family. We are assured by De Burgo that Cloghroke and Cahirforvace were the seats of two very influential branches of the De Burgos. It was occupied by John Burke in the early part of the 16th century, a gentleman who held the office of 'Sherriff of Clanricarde during the King's pleasure'. Howley Michael 'Cloughroke Castle' Hunter Ardrahan 1983, 4-5: "Cloughroke Castle was built around 600 years ago. It is quite possible it changed hangs more than once. It was inhabited probably up to the 17th century. We certainly know that a woman by the name of Norah Novack a chieftain lived there. We are not sure of the time of occupation, but folklore has it that she was a ruthless woman and showed very little respect for her subjects. At that period around 1588 the state of Galway was particularly sad it was a manner depopulated. It was also famine stricken by reason of recent warfare."
Reference:	RMP File

RMP No.:	GA096-075
Townland:	Crinnage or Ballywulash
Parish:	Killora
Barony:	Dunkellin
NGR:	150323, 219734
Classification:	Redundant Record
Dist. from development:	*c*. 40m north
Description:	The possible site represented by the enclosing element on the OS 6" sheet is now destroyed and the area is an open pasture hill.
Reference:	RMP File

RMP No.:	GA104-013 (RPS 301)
Townland:	Aggard More
Parish:	Killora

Barony:	Dunkellin
NGR:	150048, 218601
Classification:	Country House
Dist. from development:	*c*. 40m west of Aggard Stream
Description:	A house of mid to late 18th century appearance of 2 storeys over a high basement. Front of 1 bag on either side of a central 3 sided bow incorporating a fanlighted doorcase.
Reference:	RMP File

RMP No.:	GA104-054
Townland:	Aggard Beg
Parish:	Killora
Barony:	Dunkellin
NGR:	150568, 216634
Classification:	Ringbarrow and Children's Burial Ground
Dist. from development:	*c*. 45m east of Aggard Stream
Description:	This ringbarrow is situated on a slight downslope in the south-west corner of a pasture field with lower land to the south. The outer circular bank is reasonably well preserved but the central area has been denuded and is now nearer to sub-rectangular than circular. Diameter 19m. In 2001 the condition of the site is similar to that described in the 1983 report. A field wall overlies the external bank from south to west as indicated on the OS map. The term 'Lisheen' suggests the presence of a Children's Burial Ground but apart from the placename there is no evidence to suggest the presence of one.
Reference:	RMP File

RMP No.:	GA114-150
Townland:	Rathbaun
Parish:	Ardrahan
Barony:	Dunkellin
NGR:	148070, 212605
Classification:	Ringfort
Dist. from development:	*c.* 47m south-east of the Aggard Stream
Description:	This ringfort is situated on the downslope of a hill. The interior of the site is flat and featureless. It slopes internally and disturbance occurs in the southeastern quadrant. The ditch is broad and flat bottomed. Diameter 45.45m.
Reference:	RMP File

RMP No.:	GA104-004
Townland:	Aggard Beg
Parish:	Killora

Barony:	Dunkellin
NGR:	150317, 217815
Classification:	Ringfort
Dist. from development:	*c*. 60m west of Aggard Stream
Description:	This impressive bi-vallate ringfort is situated on the slight downslope of a ridge overlooking poor marshland. Another bivallate ringfort Aggard Beg 3 is within sight in the next field on higher pasture ground to the west. The interior of the site is raised above the surrounding land. Internal diameter north–south 30.8m.
Reference:	RMP File

RMP No.:	GA104-025
Townland:	Ballyglass East
Parish:	Ardrahan
Barony:	Dunkellin
NGR:	149852, 214671
Classification:	Quarry
Dist. from development:	*c*. 60m west of Aggard Stream
Description:	This site is a disused gravel pit.
Reference:	RMP File

RMP No.:	GA103-055, 001, 002
Townland:	Caherapheepa
Parish:	Killeeneen
Barony:	Dunkellin
NGR:	145248, 218572
Classification:	Cashel, souterrain and house site
Dist. from development:	*c*. 75m north
Description:	Site is shown and named 'Cahermore' on both the 1838 and 1914–1948 OS 6" mapping. The cashel is situated in a slight rise in undulating countryside. The site consists of a roughly oval shaped cashel with many internal subdivisions. The cashel was built of large boulder like limestone rocks placed on top of each other. It is however mostly collapsed, especially from west to north. In the SSW sector the wall is 1.52m in thickness with an internal height of 0.77m and external height of 1.35m. There is no trace of an entrance feature. Within one of these subdivisions in the south-west sector is a rectangular house site measuring approx. 5.1m by 3.57m. Possible souterrain not marked on either the 1838 or 1933 OS map editions. The house was picked up from the report associated with cashel site-GA103-055
Reference:	RMP File

RMP No.:	GA103-120003
Townland:	Dunkellin

Parish:	Killeely
Barony:	Dunkellin
NGR:	144163, 218216
Classification:	Church
Dist. from development:	*c*. 100m south
Description:	The site is much ruined and consists of the angles of the four walls only. The rest having been destroyed. It is situated on a south to north downward slope which forms the left bank of Dunkellin River. The site is heavily overgrown and in very poor condition. The church was an oblong single chambered mortared limestone structure laid down in uneven courses. Possible date of the 13th century.
Reference:	RMP File

RMP No.:	GA104-119
Townland:	Cloghroak
Parish:	Ardrahan
Barony:	Dunkellin
NGR:	148990, 214162
Classification:	Cist
Dist. from development:	*c.* 100m west of the Aggard Stream
Description:	Destroyed. This site probably discovered during gravel excavation operations has now disappeared completely, the ground has been levelled off. Waddell J, The Bronze Age Burials of Ireland, 1990, 93: "In 1900 a short rectangular cist was found in gravel digging, made of four slabs and covered by a capstone, it measured approximately 120cm in length, 69cm in width and 61cm in depth; the long axis lay north–south. Two vases were found, they apparently stood mouth upwards. The remains of two unburnt skeletons were found, the skulls reportedly one in each corner of the northern end. The bones were that of a young person, probably female.
Reference:	RMP File

RMP No.:	GA096-074
Townland:	Crinnage or Ballywulash
Parish:	Killora
Barony:	Dunkellin
NGR:	150489, 219953
Classification:	Ringfort
Dist. from development:	*c*. 125m north
Description:	The cashel is situated in an area of cleared scrub land. The monument has been totally destroyed.
Reference:	RMP File

RMP No.:	GA104-075
Townland:	Caherduff
Parish:	Ardrahan
Barony:	Dunkellin
NGR:	148701, 213971
Classification:	Barrow
Dist. from development:	*c.* 125m north-west of the Aggard Stream
Description:	This site was apparently destroyed during the construction of the railway line. P McCaffery, The Dunkellin Barrow Group, 1955, Pg 222: Overall diameter 67', Width of barrow 29", Width of fosse 11", Width of bank 8". The whole western part of this barrow has been destroyed by the adjacent railway.
Reference:	RMP File

RMP No.:	GA104-012
Townland:	Aggard More
Parish:	Killora
Barony:	Dunkellin
NGR:	149898, 218498
Classification:	Barrow
Dist. from development:	*c*. 130m west of Aggard Stream
Description:	The site is in level marshy land. This is an unusual platform barrow. It consists of a narrow shallow ditch which has abundant reed growth to the northeast. The ditch is a circular mound which is flat-topped. Width north–south 14.1m.
Reference:	RMP File

RMP No.:	GA104-198
Townland:	Mannin
Parish:	Ardrahan
Barony:	Dunkellin
NGR:	150314, 216899
Classification:	Holy well
Dist. from development:	*c*. 140m west of Aggard Stream
Description:	The site is a weed covered spring pool which is revetted with large boulders. Of no apparent archaeological significance. This consists of a natural spring well which feeds a pond and small stream immediately to the north. No trace of any votive offerings is visible.
Reference:	RMP File

RMP No.:	GA096-071
Townland:	Craughwell/ Crinnage or Ballywulash
Parish:	Killora

Barony:	Dunkellin
NGR:	150618, 220034
Classification:	Cashel
Dist. from development:	*c*. 150m north
Description:	The cashel is on level pasture land. The interior is much overgrown and contains a wall of field clearance in the northern sector (L 8.5m north–south, H 2.3m & W 1.8m). The enclosing element is low and of stone which has been added to by modern field clearance.
Reference:	RMP File

RMP No.:	GA104-051
Townland:	Ballynamannin
Parish:	Killora
Barony:	Dunkellin
NGR:	150611, 217547
Classification:	Ringfort
Dist. from development:	*c*. 150m east of Aggard Stream
Description:	This is a ringfort situated to the east of the railway line in an area of pasture. A univallate ringfort in a poor state of preservation. The internal diameter is 23.6m. No trace of an external bank or ditch occurs. The bank of the ringfort survives but it is very badly denuded. The interior is raised above the surrounding land. In 2001 the condition remains the same however the field wall cuts the monument at the NNW and NNE.
Reference:	RMP File

RMP No.:	GA104-041
Townland:	Ballylin West
Parish:	Killogilleen
Barony:	Dukelllin
NGR:	150799, 216109
Classification:	Castle
Dist. from development:	*c*. 150 north of the Monksfield Stream/ Aggard Stream
Description:	The tower house is situated in an area of rolling pasture. It is presently in a poor state of preservation. Constructed of mostly uncut rough stones. Stones ave been removed from all corners of the tower house but it appears that the walls were slightly battered. Externally the northern wall, measures 8.6m in length. The eastern wall measures 7.3m in length. Stones have been removed from the south-west corner of the south wall which measures 8.3m long. A destroyed doorway occurs in the western wall. The stairway on the turret is destroyed. OPW Field Notes 2001: The condition of this 3 storey tower house is the same as that noted in 1983, but the tower house is now heavily overgrowen with ivy. Access

	is gained by a robbed out doorway in the eastern wall. On the south side of the doorway a hanging eye survives. The doorway in the main ground floor chamber has been robbed out but the north side survives. A pointed vault running east-west roofs the 1st floors. Garderobe exist chutes are visible on the ground floor at the eastern end of the south wall and western end of the north wall.
Reference:	RMP File

RMP No.:	GA104-197
Townland:	Mannin
Parish:	Ardrahan
Barony:	Dunkellin
NGR:	150311, 216841
Classification:	Castle
Dist. from development:	*c*. 160m west of Aggard Stream
Description:	The tower house is situated on a slight rise over looking a river to the east. It is rectangular in plan. Ground floor measurements are 9.80m long on the western wall and 5.35m long on the northern wall. There are two entrances on the ground floor. The main chamber is barrel vaulted. H.T. Knox and a Colleague 'Notes on the Burqus of Athenry' JGAHS Vol. II, Pg 23: "Mannin Castle is a notable instance of the last sort, in as much as the stone work is wholly different from anything of its kind known in Mayo and Galway. It would seem to have been one of the very earliest and was probably built by the Desmond Geraldine of the Cantred of Kerry Loughnerney. Nolan J.P. 'Galway Castles and Owners in 1574' JGAHS Vol. I 1901, 113: "The date of the annexed List is 1574. It seems to have been compiled for the use of the Lord Deputy, Sir Henry Sidney, who planned the composition of Connaught, which was carried into the effect by Sir John Perrot, 1585."
Reference:	RMP File

RMP No.:	GA114-109, 001
Townland:	Lackan
Parish:	Ardrahan
Barony:	Dunkellin
NGR:	147725, 212828
Classification:	Ringfort and Souterrain
Dist. from development:	*c.* 160m west of the Aggard Stream
Description:	This is a multivallate ringfort situated in an area of pasture. Its condition is fair, but the interior is very overgrown. Two souterrains are located in the south-west quadrant and there is one souterrain in the south-east quadrant. The banks are well preserved and are composed of stone and soil. The internal diameter of the site is 60m. In the south-west quadrant some modern disturbance is evident in the form of a narrow curving trench.

	This souterrain is situated in the southeast quadrant of a ringfort. It is in very good condition. It is an L shaped construction. The side walls are composed of well built drystone walling. Length 9.3m north–south, 5.5m east–west.
Reference:	RMP File

RMP No.:	GA096-069
Townland:	Craughwell
Parish:	Killora
Barony:	Dunkellin
NGR:	150797, 220117
Classification:	Children's burial ground
Dist. from development:	*c*. 175m north
Description:	Access to the site from the road along the western side of the railway line. The site is situated on a slight north–south slope beside the Limerick-Athenry railway line. It is sub-rectangular in shape measuring 18.15m by 15m and is partially overgrown. The site is bound by field walls along the south, west and north and by the railway on the east. Most of the headstones are recumbent but in the south-west sector upright stones can be seen. The average dimensions of the stones are 0.3m high by 0.23m and 0.06m thick.
Reference:	RMP File

RMP No.:	GA104-206
Townland:	Monksfield
Parish:	Killogilleen
Barony:	Dunkellin
NGR:	150298, 215052
Classification:	Ringfort
Dist. from development:	*c*. 175m east of Aggard Stream
Description:	Ringfort destroyed due to field clearance.
Reference:	RMP File

RMP No.:	GA104-006
Townland:	Aggard Beg
Parish:	Killora
Barony:	Dunkellin
NGR:	150090, 217425
Classification:	Ringfort
Dist. from development:	*c*. 190m west of Aggard Stream
Description:	This bivallate ringfort is situated on an esker ridge which runs in a north–south direction. The interior is level and featureless and the inner bank is reasonably well preserved. The outer bank is completely destroyed in the south-west. Internal

	diameter north–south 19.8m.
Reference:	RMP File

RMP No.:	GA114-006
Townland:	Ballyboy
Parish:	Ardrahan
Barony:	Dunkellin
NGR:	147769, 213054
Classification:	Standing Stone
Dist. from development:	*c.* 230m north-west of the Aggard Stream
Description:	The standing stone is situated in pasture on a rise. At the base of the stone, stone packing occurs. The stone has suffered weathering and polishing. The dimensions are 1.45m high, 0.31m wide at front, 0.17cm wide at side and 0.16m wide at top.
Reference:	RMP File

RMP No.:	GA103-053, 001
Townland:	Caherapheepa
Parish:	Killeeneen
Barony:	Dunkellin
NGR:	145083, 218916
Classification:	Cashel and house site
Dist. from development:	*c.* 250m north
Description:	In 1983 the site was situated on a large expanse of rock outcrop covered with trees bushes and scrub. The site was not located due to impenetrable undergrowth. The site was not identified in 1992. This possible house site referred to by McCaffrey (1952, 185) is associated with this cashel. No further details on file.
Reference:	RMP File

RMP No.:	GA103-133
Townland:	Killeely More
Parish:	Killeely
Barony:	Dunkellin
NGR:	142489, 218334
Classification:	House - 18th/19th century
Dist. from development:	*c.* 250m south
Description:	Site is shown and titled 'Glebe House' on the 1839 and 1933 OS map editions. No further details on file.
Reference:	RMP File

RMP No.:	GA104-074001–3

Townland:	Caherapheepa/ Fahymactibbot
Parish:	Killeeneen
Barony:	Dunkellin
NGR:	145926, 219021
Classification:	Cashel, souterrain and burial ground
Dist. from development:	*c*. 250m north
Description:	The site is a bivallate cashel situated in undulating terrain. The site was badly damaged during field clearance. The site is a not large but very strong fort displaying the unusual features of two concentric stone walls built of large stones filled with rubble. The inner wall is 7ft and the outer 9ft thick and between them is a passage 27ft wide. The remains are heavily overgrown. Less than a quarter remains, that being the northern quadrant. The souterrain lies in the northern section and east of the internal dividing wall of the bivallate cashel. Three lintels are visible and a fourth has been removed. The interior has been used as a modern rubbish dump. The souterrain is aligned north-east–south-west and what remains of the chamber measures 3.9m. The site was once used as a graveyard and when afterwards it was cultivated numbers of pipes were dug up. The old custom of burying pipes on graves.
Reference:	RMP File

RMP No.:	GA104-116
Townland:	Cloghroak
Parish:	Ardrahan
Barony:	Dunkellin
NGR:	148959, 214572
Classification:	Cashel and souterrain
Dist. from development:	*c.* 270m west of the Aggard Stream
Description:	A cashel is situated in a field of pasture on a downslope. All that remains of what would have been a cashel is a slight collapsed wall to the west. The remainder has been badly disturbed due to field clearance. A souterrain occurs in the north-west quadrant. This Souterrain is situated in the south western sector of a cashel. It is inaccessible owing to its entrance being blocked. It is heavily overgrown also thereby making it impossible to ascertain its direction.
Reference:	RMP File

RMP No.:	GA103-103
Townland:	Castlegar
Parish:	Killeely
Barony:	Dunkellin
NGR:	143837, 218651
Classification:	Castle

Dist. from development:	*c*. 275m north
Description:	It was very difficult to pinpoint the precise location of this site. The site of the castle is SSW of the road overlooking a large pond below. All that remains is a ridge of earth and stones which runs down from the road to the pond below.
Reference:	RMP File

RMP No.:	GA104-003
Townland:	Aggard Beg
Parish:	Killora
Barony:	Dunkellin
NGR:	150060, 217806
Classification:	Ringfort
Dist. from development:	*c*. 285m west of Aggard Stream
Description:	The ringfort is situated on a rise in rolling pastureland. There are traces of a ditch in some areas and a berm in others. The internal bank is not high in any section. The internal diameter on the NNE–SSW axis is 31.4m.
Reference:	RMP File

RMP No.:	GA104-001
Townland:	Aggard Beg
Parish:	Killora
Barony:	Dunkellin
NGR:	149842, 218022
Classification:	Ringfort
Dist. from development:	*c*. 290m west of Aggard Stream
Description:	Fairly well preserved ringfort situated on a slight downslope. A shallow ditch runs from the inner bank in the west towards the north in the interior. It is most likely modern interference. The original entrance is in the eastern section. Internal diameter north to south 36.8m.
Reference:	RMP File

RMP No.:	GA103-049, 001
Townland:	Rinn
Parish:	Killeely
Barony:	Dunkellin
NGR:	144520, 218118
Classification:	Cashel and souterrain
Dist. from development:	*c*. 300m south
Description:	A roughly circular cashel which is now destroyed from the SSE right around in a clockwise fashion to the WNW. There appears to be a bank of collapse first WSW of

	centre. It is situated in a fairly flat field in low lying terrain. In a rather poor state. It is present from the WNW to SSE where although it is grass covered large stones protrude through. Internal diameter 37m north-west to south-east. The souterrain runs in a NNW to SSE direction, the original entrance is still visible but the initial 4m is completely collapsed, after this point however access becomes possible. The width of the lintel at the original entrance measures 1.25m and 0.15m H. The existing entrance is situated 4m from the original entrance and is formed by a portion of the souterrain collapsing. The walls consist of drystone walling while the roof is composed of lintels.
Reference:	RMP File

RMP No.:	GA096-070
Townland:	Craughwell
Parish:	Killora
Barony:	Dunkellin
NGR:	150907, 220371
Classification:	Church
Dist. from development:	*c*. 300m north
Description:	Site is shown and titled 'Roman Catholic Chapel' on the 1839 OS map edition, is also shown and named 'St. Colmass Catholic Church' on the 1933 6" OS map edition. No further details on file.
Reference:	RMP File

RMP No.:	GA104-247
Townland:	Aggard Beg
Parish:	Killora
Barony:	Dunkellin
NGR:	150029, 216305
Classification:	Enclosure
Dist. from development:	*c*. 300m west of Aggard Stream
Description:	This hut site is situated on an esker ridge overlooking lower pastureland. The hut is sub-circular in form and its interior is revetted by large boulders. There is a definite entrance feature in the ESE where a narrow passage 2.75m wide and 5.3m long gives access to the interior. Diameter north–south 8.5mm.
Reference:	RMP File

RMP No.:	GA104-115
Townland:	Cloghroak
Parish:	Ardrahan
Barony:	Dunkellin
NGR:	149130, 214652
Classification:	House site

Dist. from development:	*c.* 320m west of the Aggard Stream
Description:	According to McCaffery a hut site existed here. However, nothing of apparent archaeological significance could be located. McCaffrey P. “A contribution to the Archaeology of the Barony of Dunkellin, Co. Galway, 1952, 226: “Hut circle Width 12’ 9” x 5’ 5” (not on OS maps). Circular overall diameter 47’. The surrounding wall is 3’ wide and 1’ 9” internally and 1’ externally. The wall composed of two faces of blocks set on edge.
Reference:	RMP File

RMP No.:	GA103-104
Townland:	Castlegar
Parish:	Killeely
Barony:	Dukelllin
NGR:	143808, 218700
Classification:	Souterrain
Dist. from development:	*c.* 350m north
Description:	This souterrain is situated behind a farmhouse. When building a new house in the area of the souterrain was discovered. It is now completely blocked up with only the lintel stone at the entrance remaining visible. File also contains mention of a number of skeletons uncovered at the site in the 1960s. Approximately 4 or 5 lying east–west direction. No further details given.
Reference:	RMP File

RMP No.:	GA104-037
Townland:	Ballylin West
Parish:	Killogilleen
Barony:	Dukelllin
NGR:	150734, 216269
Classification:	Ringfort
Dist. from development:	*c.* 350m east of the Aggard Stream
Description:	The ringfort is situated on a height in an area of pasture. All that remains is a slight circular ridge. The NNE portion is completely destroyed. In 1992 this circular rath 35m in diameter is defined by a much denuded bank which as been destroyed from NNW to east by the construction of a drystone walled vegetable garden. From east–south the bank is only 20cm high and 7m wide. No trace of an entrance, fosse or any internal or external features survives. In 2001 there is no trace of the enclosing element at NNW. From north to north-east it is defined by a low bank which is 2m wide and 0.3m high over the external ground level. Field walls cut the monument. A small area denuded of sod cover in western sector indicates that the enclosing element is made up of stone and rock.
Reference:	RMP File

RMP No.:	GA104-213
Townland:	Monksfield
Parish:	Killogilleen
Barony:	Dunkellin
NGR:	150505, 214991
Classification:	House
Dist. from development:	*c*. 350m east of Aggard Stream
Description:	Site is marked and titled 'Monksfield' on the 1838 1st edition OS mapping. No further details on file.
Reference:	RMP File

RMP No.:	GA104-250
Townland:	Rathcosgry
Parish:	Ardrahan
Barony:	Dunkellin
NGR:	149647, 215138
Classification:	Cashel
Dist. from development:	*c*. 350m west of Aggard Stream
Description:	This probable cashel is situated on a natural height in a field of pasture. A circular structure surrounded by a low bank. In interior is flat and featureless and is dissected by a wall running NNE/SSW. Internal diameter measures 19.4m from north–south. No bank or external ditch occurs.
Reference:	RMP File

RMP No.:	GA104-111
Townland:	Cloghroak
Parish:	Ardrahan
Barony:	Dunkellin
NGR:	149446, 214880
Classification:	Ringfort
Dist. from development:	*c*. 360m west of Aggard Stream
Description:	This site was completely destroyed due to field clearance. McCaffrey P. 'A contribution to the archaeology of the barony of Dunkellin, Co. Galway.' 1952, 227.: Original diameter 112'
Reference:	RMP File

RMP No.:	GA114-110
Townland:	Lackan
Parish:	Ardrahan
Barony:	Dunkellin

NGR:	148555, 212683
Classification:	Barrow
Dist. from development:	*c.* 360m north-west of the Aggard Stream
Description:	Situated on a small hummock in gently undulating to flat pastureland. Poorly preserved remains of what appears to be a ring-barrow measuring 19.7m approx. NNW-SSE axis. The western half of the site is almost completely levelled and even in the eastern half the bank has a very shallow ploughed out profile.
Reference:	RMP File

RMP No.:	GA104-026
Townland:	Ballyglass East
Parish:	Ardrahan
Barony:	Dunkellin
NGR:	149843, 214183
Classification:	Ringfort
Dist. from development:	*c.* 370m south of the Aggard Stream
Description:	This site has been destroyed due to field clearance. Overall diameter was originally 96' x 82'.
Reference:	RMP File

RMP No.:	GA103-179
Townland:	Stradbally South
Parish:	Kilcolgan
Barony:	Dunkellin
NGR:	141489, 218389
Classification:	Mill (unidentified)
Dist. from development:	*c.* 380m west
Description:	On the south bank of the Kilcolgan River is a rectangular building (14m north–south; 6m east–west) defined by grassed-over foundation lines except at south where a gable wall containing two plain rectangular windows survives. Traces of a mill race, now filled with field clearance rubble, are visible within this structure. This is possibly the site of the medieval mill attached to the borough of Kilcolgan (Holland 1988, 81).
Reference:	RMP File

RMP No.:	GA096-122
Townland:	Killora
Parish:	Killora
Barony:	Dunkellin
NGR:	151425, 219590
Classification:	Ringfort

Dist. from development:	*c*. 400m south
Description:	The site has been totally destroyed due to field clearance.
Reference:	RMP File

RMP No.:	GA103-121
Townland:	Dunkellin
Parish:	Killeely
Barony:	Dunkellin
NGR:	143452, 218001
Classification:	Mound – non antiquity
Dist. from development:	*c*. 400m south
Description:	The site appears to be nothing more than a group of stones gathered together during field clearance activities.
Reference:	RMP File

RMP No.:	GA096-004
Townland:	Ballymore
Parish:	Killeenawara
Barony:	Dunkellin
NGR:	151474, 220313
Classification:	Country house
Dist. from development:	*c*. 400m east
Description:	Monument is shown but not named on the 1839 6" OS edition but is shown and named on the 1933 edition. No further details on file.
Reference:	RMP File

RMP No.:	GA104-010
Townland:	Aggard Beg
Parish:	Killora
Barony:	Dunkellin
NGR:	149858, 217477
Classification:	Mound
Dist. from development:	*c*. 400m west of Aggard Stream
Description:	Some 7m east of the outer ditch of Aggard Beg ringfort no. 5 is a sub-circular platform-like area reminiscent of the central area of a ringbarrow. However no characteristic features such as internal ditch or outer bank can be seen. The mound does not look natural and is apparently man-made. Width 8.2m east–west.
Reference:	RMP File

RMP No.:	GA104-042

Townland:	Ballylin West
Parish:	Killogilleen
Barony:	Dukelllin
NGR:	150766, 216296
Classification:	Souterrain
Dist. from development:	*c*. 400 east of the Aggard Stream
Description:	This Souterrain is not marked on the OS 6” map. However, according to local information lintels of a cave were discovered during JCB work. The landowner informed us that he sealed the Souterrain about twenty years ago to prevent injury to livestock.
Reference:	RMP File

RMP No.:	GA104-109
Townland:	Cloghroak
Parish:	Ardrahan
Barony:	Dunkellin
NGR:	149550, 215096
Classification:	Ringfort
Dist. from development:	*c*. 400m west of Aggard Stream
Description:	This site has been destroyed totally during the course of field clearance activities. Original diameter 158’.
Reference:	RMP File

RMP No.:	GA104-117002
Townland:	Cloghroak
Parish:	Ardrahan
Barony:	Dunkellin
NGR:	148740, 214370
Classification:	Field System
Dist. from development:	*c*. 440m west of the Aggard Stream
Description:	The field system mentioned in McCaffrey has also been cleared. McCaffrey, P. “A contribution to the Archaeology of the Barony of Dunkellin, Co. Galway”, 1952 226: “South of this site on the lower ground of the same field are the remains of an older field system.”
Reference:	RMP File

RMP No.:	GA103-054
Townland:	Caherapheepa
Parish:	Killeeneen
Barony:	Dunkellin
NGR:	145430, 218880

Classification:	Cashel
Dist. from development:	*c*. 450m north
Description:	Site is shown and named 'Caherbeg' on both the 1838 & 1928 6" OS map editions. The site consists of a cashel situated in a very overgrown flat area. Because of the undergrowth not all sectors of the site were accessible. The cashel is roughly oval with its long axis in a WSW–ENE direction. There is a good deal of collapse from south-east to south-west. From west to north there is a high wall which is probably a modern field boundary built on the collapsed cahsel. There are scatterings of collapse in the centre of the site. The eastern section the base of the collapse measures 5.6m.
Reference:	RMP File

RMP No.:	GA103-178, 001
Townland:	Stradbally south
Parish:	Kilcolgan
Barony:	Dunkellin
NGR:	141390, 218456
Classification:	Enclosure and Souterrain
Dist. from development:	c. 450m west
Description:	No detail
Reference:	RMP File

RMP No.:	GA104-005
Townland:	Aggard Beg
Parish:	Killora
Barony:	Dunkellin
NGR:	149824, 217459
Classification:	Ringfort
Dist. from development:	*c*. 460m west of Aggard Stream
Description:	This ringfort is situated on an east–west running esker ridge. The interior is relatively level. Its only feature is a ditch which runs for *c*. 8m eastwards from the west inner bank. The ditch is *c*. 2.3m wide and 1.3m deep. Internal diameter north–south 27.4m, external diameter north–south 48.4m.
Reference:	RMP File

RMP No.:	GA104-110
Townland:	Cloghroak
Parish:	Ardrahan
Barony:	Dunkellin
NGR:	149303, 214921
Classification:	Cairn

Dist. from development:	*c*. 470m west of Aggard Stream
Description:	This site may have been a ringbarrow but it is now completely destroyed due to field clearance. Original diameter was 12.2m.
Reference:	RMP File

RMP No.:	GA104-256, 001
Townland:	Roo
Parish:	Killora
Barony:	Dunkellin
NGR:	150548, 218453
Classification:	Souterrains
Dist. from development:	*c*. 470m east of Aggard Stream
Description:	Upon investigation it is more than likely a Souterrain but inaccessible. No associated earthworks lie in its vicinity. It is situated on level ground at the south end of a field of rough pasture land. A small lintel-the possible entrance is visible, 8.4m west of this point an area of collapse marks the probable end of the monument. In the next field to the southeast only a few meters away is another un-associated souterrain Roo 5. It could not be determined if the two originally joined.
Reference:	RMP File

RMP No.:	GA104-151
Townland:	Killora
Parish:	Killora
Barony:	Dunkellin
NGR:	150954, 219094
Classification:	Souterrain
Dist. from development:	*c.* 470m east of the Aggard Stream
Description:	The site is on a height overlooking a turlough. A modern pathway runs over some of the structure. The Souterrain is completely inaccessible and partly destroyed. One capstone and some portions are visible. In 1992 the area was thoroughly checked but no trace of the souterrain was found. Sub-surface remains may survive intact but there are no surface indications of its presence.
Reference:	RMP File

RMP No.:	GA104-248, 001
Townland:	Rathcosgry
Parish:	Ardahan
Barony:	Dunkellin
NGR:	149851, 216238
Classification:	Cashel and Souterrain
Dist. from	*c.* 470m west of the Aggard Stream

development:	
Description:	This badly preserved cashel lies in the corner of a level pasture field. The low enclosing element of earth and stone has modern field clearance added to it. There is no obvious entrance feature. The interior is uneven and has the remains of a possible hut site in the east sector. Diameter east–west 22.6m. A souterrain was recorded as present in 1952.
Reference:	RMP File

RMP No.:	GA103-018
Townland:	Ballynabucky
Parish:	Killeely
Barony:	Dunkellin
NGR:	143742, 217871
Classification:	Ringfort
Dist. from development:	*c.* 500m south
Description:	No details
Reference:	RMP File

RMP No.:	GA104-011
Townland:	Aggard More
Parish:	Killora
Barony:	Dunkellin
NGR:	149810, 219270
Classification:	Cashel
Dist. from development:	*c.* 500m west of Aggard Stream
Description:	Not marked or shown on later map editions. Due to heavy undergrowth the site could not be located.
Reference:	RMP File

RMP No.:	GA104-117, 1
Townland:	Cloghroak
Parish:	Ardrahan
Barony:	Dunkellin
NGR:	148671, 214426
Classification:	Cashel and souterrain, field system
Dist. from development:	*c.* 500m west of the Aggard Stream
Description:	The site stood on a gentle southern slope. Extensive land clearance has occurred in this area and no surface trace is present. There is now a thin soil and grass cover. The field system and elliptical enclosures mentioned in McCaffrey have also been cleared.
Reference:	RMP File

RMP No.:	GA104-011
Townland:	Aggard More
Parish:	Killora
Barony:	Dunkellin
NGR:	149810, 219270
Classification:	Cashel
Dist. from development:	*c.* 500m west of the Aggard Stream
Description:	Due to heavy undergrowth the site could not be located.
Reference:	RMP File

RMP No.:	GA104-285
Townland:	Cloghroak
Parish:	Ardrahan
Barony:	Dunkellin
NGR:	148942, 214006
Classification:	Ring Barrow
Dist. from development:	*c.* 53m west of the Aggard Stream
Description:	This site appears to be a small barrow. It is situated on the southern shoulder of a slight ridge and is cut into the shoulder of the ridge. The site consists of a shallow circular ditch, in the centre is a small mound. The site is *c*. 9m in diameter east-west. The central mound is *c*. 3m in diameter east–west.
Reference:	RMP File

D2 Stray Finds

STRAY FINDS WITHIN THE SURROUNDING AREA

Information on artefact finds from the study area in County Galway has been recorded by the National Museum of Ireland since the late 18th century. Location information relating to these finds is important in establishing prehistoric and historic activity in the study area.

Museum No:	1931:10
Townland:	Kilcornan
Parish:	Stradbally
Barony:	Dunkellin
Find:	Bronze Kite shaped side-looped spear head
Find place:	unknown
Description:	Bronze Kite shaped side-looped spear head
Reference:	Topographical File

Museum No:	1943:251
Townland:	Kilcolgan (river) (OS sheet 103)
Parish:	Kilcolgan
Barony:	Dunkellin
Find:	Salmon Spear
Find place:	unknown
Description:	Salmon Spear
Reference:	Topographical File

Museum No:	1996:9
Townland:	Killora (OS sheet 104)
Parish:	Killora
Barony:	Dunkellin
Find:	Iron slag
Find place:	Graveyard GA104-151
Description:	Iron slag found during graveyard clear up GA104-151
Reference:	Topographical File

Museum No:	Record Only
Townland:	Kilcornan
Parish:	Stradbally
Barony:	Dunkellin
Find:	Encrusted urn
Find place:	unknown
Description:	Encrusted urn from Kilcornan, near Clarinbridge (1960s)
Reference:	Topographical File

Museum No:	1938:9225

Townland:	Shantallow
Parish:	Ardrahan
Barony:	Dunkellin
Find:	Stone Axehead
Find place:	Found in a field *c*. 3.5 miles from Oranmore.
Description:	Stone Axehead
Reference:	NMI Topographical Files

Museum No:	1934:4368-4403
Townland:	Mannin
Parish:	Ardrahan
Barony:	Dunkellin
Find:	7 Miscellaneous Rounded Stones, 29 Miscellaneous Beads (in 3 groups) of glass, stone and metal.
Find place:	D'Evelyn Collection
Description:	No further details on file.
Reference:	NMI Topographical Files

Museum No:	Record
Townland:	Cloghroak
Parish:	Ardrahan
Barony:	Dunkellin
Find:	'Urns' and Skeletal Remains
Find place:	Cist
Description:	Excavation in 1916 of a Bronze-Age cemetery near Clochroke (Cloghroak) Castle, where a cist had been disinterred some years before. No further details on file.
Reference:	NMI Topographical Files

Museum No:	Record
Townland:	Ballylin West
Parish:	Killogilleen
Barony:	Dunkellin
Find:	Animal Bones, Oyster Shells, Child's Mandible, Charcoal.
Find place:	House and souterrain monument through excavation by the museum *c*. 1930.
Description:	The animal bones were examined and found to form about a 1/3 of a full-grown pony which was considered to have been buried in modern times. Charcoal identified as hazel. The structure had some similarity with a stone circle. Uprights were standing forming a rather circular outline. The style of buildings consists of revetting the excavated spaces and this was so crudely done it could be taken as a prototype for the Souterrain
Reference:	NMI Topographical Files

Museum No:	IAG/860

Townland:	Ballybaun or Shantallow
Parish:	Ardrahan
Barony:	Dunkellin
Find:	Ecclesiastical Enclosure
Find place:	Vinegar, Ardrahan
Description:	Pieces of human bone including skull, vertebrae and long bones were recovered. A well defined circular wall surrounded the area of the badger burrows where the remains were found. The outer circle measured 60m in diameter. Outside the outer circle to the east is a small circular foundation and to the west the OS maps show some sort of foundation. Prof. Rynne said the site was probably a 7th or 8th century monastic settlement.
Reference:	NMI Topographical Files

D3 Protected Structures and NIAH Structures

PROTECTED STRUCTURES AND NIAH STRUCTURES WITHIN THE SURROUNDING AREA

RPS No:	None (proposed)
NIAH No.:	30336010
Townland:	Craughwell
Parish:	Killora
Barony:	Dunkellin
NGR:	151070, 219931
Classification:	Road Bridge - Craughwell Bridge
Dist. from development:	0m
Description:	Six-arch limestone road bridge over Craughwell River, built *c*. 1600 and widened to west perhaps late seventeenth century and to east *c*. 1780. Original bridge was ten feet wide, early widening added two feet and later widening added same width again as original bridge. Formerly in use as vehicular bridge, now bypassed and in use as pedestrian bridge. Well preserved wicker centring to soffits of earliest part, and partly hidden arch ring towards west side of bridge, is of irregular voussoirs. Rubble stone walls, piers and parapet walls. Piers apparently refaced in squared limestone blocks, perhaps at time of latest work. Segmental arches to east elevation with cut-stone voussoirs and dressed stone V-cutwaters. Pointed round and segmental to west elevation. This attractive bridge is of considerable importance due to its complex history. The survival of well preserved wicker centring is significant. The varying nature of the elevations and arches adds visual and historic interest, and the various phases of the structure are indicative of the engineering of their periods. The good-quality stonework is a testament to the skills and engineering of local craftsmen. Its early date adds to its significance and gives it archaeological as well as architectural interest. The bridge is an important component of the village of Craughwell and was a key part of the national road infrastructure, having carried traffic between Dublin and Galway for four centuries.
Categories of Special Interest:	Historical, Archaeological and Architectural Heritage
Rating:	Regional
Reference:	www.buildingsofireland.ie

RPS No:	None
NIAH No.:	30410332
Townland:	Dunkellin
Parish:	Killeely
Barony:	Dunkellin

NGR:	144202, 218420
Classification:	Dunkellin Bridge
Dist. from development:	0m
Description:	Seven-arch bridge, built *c*. 1820, carrying road over the Dunkellin River. Arches comprise central segmental river arch of *c*. 1870, and three smaller round arches to north, now dry, and three to south. Square-headed opening to north in rebuilt mass concrete wall. Dressed and rubble limestone walls having dressed limestone voussoirs to arches.
Categories of Special Interest:	Historical and Architectural Heritage
Rating:	Regional
Reference:	www.buildingsireland.ie

RPS No:	302
NIAH No.:	None
Townland:	Aggard More
Parish:	Killora
Barony:	Dunkellin
NGR:	150400, 219180
Classification:	Aggard Bridge
Dist. from development:	0m
Description:	Masonry bridge crossing Aggard Stream
Categories of Special Interest:	Historical and Architectural Heritage
Rating:	Regional
Reference:	Galway Co. Co. Development Plan

RPS No:	None
NIAH No.:	30336008
Townland:	Craughwell
Parish:	Killora
Barony:	Dunkellin
NGR:	150855, 219961
Classification:	Rail Bridge – Grenage Bridge
Dist. from development:	20m north
Description:	Single-arch limestone railway bridge, built 1869, carrying Ennis to Athenry railway line over local road. Snecked rock-faced rusticated limestone piers and buttresses. Segmental arch with tooled rock-faced rusticated voussoirs and dressed stone soffit to elliptical arch. Parapet rebuilt in concrete blockwork with recent railings above. While it serves the same purpose as the nearby Aggard railway bridge, the difference in form, treatment and

	character between the two highlights the skills of the masons involved.
Categories of Special Interest:	Historical and Architectural Heritage
Rating:	Regional
Reference:	www.buildingsofireland.ie

RPS No:	301
NIAH No.:	30410402
Townland:	Aggard More
Parish:	Killora
Barony:	Dunkellin
NGR:	150050, 218600
Classification:	Aggard house
Dist. from development:	*c*. 40m west of Aggard Stream
Description:	Detached L-plan three-bay two-storey country house with raised basement, built *c*. 1780, with slightly lower canted entrance bay to front (west) elevation, and having one-bay full-height addition to rear to give two-bay north and three-bay south elevations. Now in use as house. Ornamentation is focused on the fine limestone doorcase with its unusual finials, the entrance being further emphasised by the splayed flight of cut-stone steps. The diminishing windows are a typical feature of high status homes of the eighteenth and early nineteenth centuries. The setting of the house is enhanced by its yard of outbuildings.
Categories of Special Interest:	Historical and Architectural Heritage
Rating:	Regional
Reference:	Galway Co. Co. Development Plan, www.buildingsireland.ie

RPS No:	None
NIAH No.:	30336009
Townland:	Craughwell
Parish:	Killora
Barony:	Dunkellin
NGR:	150871, 219864
Classification:	Rail Bridge – Aggard Bridge
Dist. from development:	*c*. 50m south
Description:	Single-arch limestone railway bridge, built 1869, carrying Ennis to Athenry railway line over road. Coursed rock-faced rusticated limestone abutments and buttresses. Parabolic arch with tooled rock-faced rusticated voussoirs and cut-stone soffit.
Categories of Special Interest:	Historical and Architectural Heritage

Rating:	Regional
Reference:	www.buildingsofireland.ie

RPS No:	None, LAP Structure of Local Interest
NIAH No.:	30336007
Townland:	Craughwell
Parish:	Killora
Barony:	Dunkellin
NGR:	151043, 220120
Classification:	Garda Station
Dist. from development:	58m north
Description:	Detached three-bay two-storey former RIC police barracks, built c.1830, having flat-roofed windbreak to front (west) elevation. Now in use as Garda station. Pitched slate roof having clay ridge tiles with painted smooth rendered chimneystacks and cast-iron rainwater goods.
Categories of Special Interest:	Historical and Architectural Heritage
Rating:	Regional
Reference:	www.buildingsofireland.ie

RPS No:	none
NIAH No.:	30410405
Townland:	Mannin/ Ballylin West
Parish:	Ardrahan
Barony:	Dunkellin
NGR:	150438, 216755
Classification:	Rail Bridge
Dist. from development:	*c.* 90m west of Aggard Stream
Description:	Single-arch limestone railway bridge, built 1869, carrying road over Ennis Junction to Athenry railway line. Snecked rock-faced rusticated walls, piers, parapet walls and abutment walls, recent rendered coping to parapet walls. Ashlar soffit. Segmental arch with rock-faced rusticated voussoirs. Abutment walls with slight batter.
Categories of Special Interest:	Historical and Architectural Heritage
Rating:	Regional
Reference:	www.buildingsireland.ie

RPS No:	295
NIAH No.:	30410330
Townland:	Stradbally South
Parish:	Stradbally

Barony:	Dunkellin
NGR:	141699, 218450
Classification:	Kilcolgan Road Bridge
Dist. from development:	*c*. 150m west
Description:	Six-arch humpback limestone bridge, built *c*.1780, carrying road over Kilcolgan River. The varying arch types and sizes add visual interest, as does the contrast between the rubble limestone walls and cut and tooled stonework. The alterations to the bridge in the latter half of the nineteenth century were probably a response to changes in the flow of the river.
Categories of Special Interest:	Architectural Heritage
Rating:	Regional
Reference:	Galway Co. Co. Development Plan, www.buildingsireland.ie

RPS No:	None
NIAH No.:	30410335
Townland:	Killeely More
Parish:	Killeely
Barony:	Dunkellin
NGR:	142477, 218505
Classification:	Thatch Cottage
Dist. from development:	*c.* 160m south River, 15m south of proposed spread area
Description:	Detached four-bay single-storey vernacular house, built *c*.1800. Pitched thatched roof having raised scolloped ridge, and rendered chimneystack.
Categories of Special Interest:	Historical and Architectural Heritage
Rating:	Regional
Reference:	www.buildingsireland.ie

RPS No:	None, LAP Structure of Local Interest
NIAH No.:	30336006
Townland:	Craughwell
Parish:	Killora
Barony:	Dunkellin
NGR:	151003, 220136
Classification:	Thatch Cottage
Dist. from development:	188m north
Description:	Attached four-bay single-storey vernacular house, built *c.* 1800. Pitched thatched roof with decorative raised ridge, having low rendered chimneystacks.
Categories of Special	Historical and Architectural Heritage

Interest:	
Rating:	Regional
Reference:	www.buildingsofireland.ie

RPS No:	None
NIAH No.:	30336003
Townland:	Craughwell
Parish:	Killora
Barony:	Dunkellin
NGR:	150977, 220310
Classification:	Water Tower
Dist. from development:	268m north
Description:	Freestanding reinforced concrete circular-plan water tower, built *c*. 1960, consisting of three-stage tower supporting slightly water holding tank. This is an interesting mid-twentieth-century addition to the architectural heritage of South Galway. Its sculptural form is a prominent feature in the landscape, visible from a considerable distance and adding a feature of interest to the skyline of the Craughwell area.
Categories of Special Interest:	Architectural Social Technical
Rating:	Regional
Reference:	www.buildingsofireland.ie

RPS No:	246
NIAH No.:	30336002, 30336001
Townland:	Craughwell
Parish:	Killora
Barony:	Dunkellin
NGR:	150910, 220370
Classification:	St. Colman's Catholic Church, Parochial House
Dist. from development:	350m north
Description:	Free-standing gable-fronted T-plan Roman Catholic church, built c.1840, having five-bay nave and single-bay transepts, shallow chancel, and with square-plan tower over gable-front. Three-bay two-storey parochial house attached to east gable.
Categories of Special Interest:	Historical and Architectural Heritage
Rating:	Regional
Reference:	Galway Co. Co. Development Plan, www.buildingsofireland.ie

RPS No:	247
NIAH No.:	30336004, 30336005

Townland:	Ballymore
Parish:	Killora
Barony:	Dunkellin
NGR:	151510, 220340
Classification:	Ballymore Park House and Stables
Dist. from development:	*c*. 400-480m north-east
Description:	Detached five-bay two-storey country house, built c.1750, having flanking single-bay single-storey blocks recessed to each gable with half-dormer attic. Now in use as clubhouse. Pedimented entrance breakfront with later gabled porch to front (south) elevation. Single-storey return to rear, having two-storey further block to rear having two-bay first and three-bay ground floors, with further lean-to addition to north gable, and with lean-to addition to east gable of east wing of house proper. Pitched tiled roof to main block, slate roofs elsewhere, having rendered chimneystacks and cast-iron rainwater goods, with belfry to east wing. L-plan stable yard, dated 1891. East range comprising two-storey block with integral carriage archway to north end and nine-bay single-storey stables to south end. North range comprises fifteen-bay single-storey stableblock having integral carriage archway towards middle and further single-storey stable block to west.
Categories of Special Interest:	Historical and Architectural Heritage
Rating:	Regional
Reference:	Galway Co. Co. Development Plan, www.buildingsofireland.ie

D4 Legislative Framework Protecting the Archeological Resource

LEGISLATIVE FRAMEWORK PROTECTING THE ARCHAEOLOGICAL RESOURCE

Protection of Cultural Heritage

The cultural heritage in Ireland is safeguarded through national and international policy designed to secure the protection of the cultural heritage resource to the fullest possible extent (Department of Arts, Heritage, Gaeltacht and the Islands 1999, 35). This is undertaken in accordance with the provisions of the *European Convention on the Protection of the Archaeological Heritage* (Valletta Convention), ratified by Ireland in 1997.

The Archaeological Resource

The *National Monuments Act 1930 to 2004* and relevant provisions of the *National Cultural Institutions Act 1997* are the primary means of ensuring the satisfactory protection of archaeological remains, which includes all man-made structures of whatever form or date except buildings habitually used for ecclesiastical purposes. A National Monument is described as 'a monument or the remains of a monument the preservation of which is a matter of national importance by reason of the historical, architectural, traditional, artistic or archaeological interest attaching thereto' (National Monuments Act 1930 Section 2).

A number of mechanisms under the National Monuments Act are applied to secure the protection of archaeological monuments. These include the Register of Historic Monuments, the Record of Monuments and Places, and the placing of Preservation Orders and Temporary Preservation Orders on endangered sites.

Ownership and Guardianship of National Monuments

The Minister may acquire national monuments by agreement or by compulsory order. The state or local authority may assume guardianship of any national monument (other than dwellings). The owners of national monuments (other than dwellings) may also appoint the Minister or the local authority as guardian of that monument if the state or local authority agrees. Once the site is in ownership or guardianship of the state, it may not be interfered with without the written consent of the Minister.

Register of Historic Monuments

Section 5 of the 1987 Act requires the Minister to establish and maintain a Register of Historic Monuments. Historic monuments and archaeological areas present on the register are afforded statutory protection under the 1987 Act. Any interference with sites recorded on the register is illegal without the permission of the Minister. Two months notice in writing is required prior to any work being undertaken on or in the vicinity of a registered monument. The register also includes sites under Preservation Orders and Temporary Preservation Orders. All registered monuments are included in the Record of Monuments and Places.

Preservation Orders and Temporary Preservation Orders

Sites deemed to be in danger of injury or destruction can be allocated Preservation Orders under the 1930 Act. Preservation Orders make any interference with the site illegal. Temporary Preservation Orders can be attached under the 1954 Act. These perform the same function as a Preservation Order but have a time limit of six months, after which the situation must be reviewed. Work may only be undertaken on or in the vicinity of sites under Preservation Orders with the written consent, and at the discretion, of the Minister.

Record of Monuments and Places

Section 12(1) of the 1994 Act requires the Minister for Arts, Heritage, Gaeltacht and the Islands (now the Minister for the Environment, Heritage and Local Government) to establish and maintain a record of monuments and places where the Minister believes that such monuments exist. The record comprises a list of monuments and relevant places and a map/s showing each monument and relevant place in respect of each county in the state. All sites recorded on the Record of Monuments and Places receive statutory protection under the National Monuments Act 1994. All recorded monuments on the proposed development site are represented on the accompanying maps.

Section 12(3) of the 1994 Act provides that 'where the owner or occupier (other than the Minister for Arts, Heritage, Gaeltacht and the Islands) of a monument or place included in the Record, or any other person, proposes to carry out, or to cause or permit the carrying out of, any work at or in relation to such a monument or place, he or she shall give notice in writing to the Minister of Arts, Heritage, Gaeltacht and the Islands to carry out work and shall not, except in the case of urgent necessity and with the consent of the Minister, commence the work until two months after the giving of notice'.

Under the National Monuments (Amendment) Act 2004, anyone who demolishes or in any way interferes with a recorded site is liable to a fine not exceeding €3,000 or imprisonment for up to 6 months. On summary conviction and on conviction of indictment, a fine not exceeding €10,000 or imprisonment for up to 5 years is the penalty. In addition they are liable for costs for the repair of the damage caused.

In addition to this, under the *European Communities (Environmental Impact Assessment) Regulations 1989,* Environmental Impact Statements (EIS) are required for various classes and sizes of development project to assess the impact the proposed development will have on the existing environment, which includes the cultural, archaeological and built heritage resources. These document's recommendations are typically incorporated into the conditions under which the proposed development must proceed, and thus offer an additional layer of protection for monuments which have not been listed on the RMP.

The Planning and Development Act 2000

Under planning legislation, each local authority is obliged to draw up a Development Plan setting out their aims and policies with regard to the growth of the area over a five-year period. They cover a range of issues including archaeology and built heritage, setting out their policies and objectives with regard to the protection and enhancement of both. These policies can vary from county to county. The Planning and Development Act 2000 recognises that proper planning and sustainable development includes the protection of the archaeological heritage. Conditions relating to archaeology may be attached to individual planning permissions.

LEGISLATION FRAMEWORK PROTECTING THE ARCHITECTURAL RESOURCE

The main laws protecting the built heritage are the *Architectural Heritage (National Inventory) and National Monuments (Miscellaneous Provisions) Act 1999* and the *Local Government (Planning and Development) Acts 1963-1999*, which has now been superseded by the *Planning and Development Act, 2000*. The Architectural Heritage Act requires the Minister to establish a survey to identify, record and assess the architectural heritage of the country. The background to this legislation derives from Article 2 of the 1985 Convention for the Protection of Architectural Heritage (Granada Convention). This states that:

For the purpose of precise identification of the monuments, groups of structures and sites to be protected, each member state will undertake to maintain inventories of that architectural heritage.

The National Inventory of Architectural Heritage (NIAH) was established in 1990 to fulfil Ireland's obligation under the Granada Convention, through the establishment and maintenance of a central record, documenting and evaluating the architecture of Ireland (NIAH Handbook 2005:2). As inclusion in the inventory does not provide statutory protection, the survey information is used in conjunction with the *Architectural Heritage Protection Guidelines for Planning Authorities* to advise local authorities on compilation of a Record of Protected Structures as required by the *Planning and Development Act, 2000*.

Protection under the Record of Protected Structures and County Development Plan
Structures of architectural, cultural, social, scientific, historical, technical or archaeological interest can be protected under the Planning and Development Act, 2000, where the conditions relating to the protection of the architectural heritage are set out in Part IV of the act. This act superseded the Local Government (Planning and Development) Act, 1999, and came into force on 1st January 2000.

The act provides for the inclusion of Protected Structures into the planning authorities' development plans and sets out statutory regulations regarding works affecting such structures. Under new legislation, no distinction is made between buildings formerly classified under development plans as List 1 and List 2. Such buildings are now all regarded as 'Protected Structures' and enjoy equal statutory protection. Under the act the entire structure is protected, including a structure's interior, exterior, attendant grounds and also any structures within the attendant grounds.

The act defines a Protected Structure as (a) a structure, or (b) a specified part of a structure which is included in a Record of Protected Structures (RPS), and, where that record so indicates, includes any specified feature which is in the attendant grounds of the structure and which would not otherwise be included in this definition. Protection of the structure, or part thereof, includes conservation, preservation, and improvement compatible with maintaining its character and interest. Part IV of the act deals with architectural heritage, and Section 57 deals specifically with works affecting the character of Protected Structures or proposed Protected Structures and states that no works should materially affect the character of the structure or any element of the structure that contributes to its special architectural, historical, archaeological, artistic, cultural, scientific, social or technical interest. The act does not provide specific criteria for assigning a special interest to a structure. However, the National Inventory of Architectural Heritage (NIAH) offers guidelines to its field workers as to how to designate a building with a special interest, which are not mutually exclusive. This offers guidance by example rather than by definition:

Archaeological

It is to be noted that the NIAH is biased towards post-1700 structures. Structures that have archaeological features may be recorded, providing the archaeological features are incorporated within post-1700 elements. Industrial fabric is considered to have technical significance, and should only be attributed archaeological significance if the structure has pre-1700 features.

Architectural

A structure may be considered of special architectural interest under the following criteria:

- Good quality or well executed architectural design
- The work of a known and distinguished architect, engineer, designer, craftsman
- A structure that makes a positive contribution to a setting, such as a streetscape or rural setting
- Modest or vernacular structures may be considered to be of architectural interest, as they are part of the history of the built heritage of Ireland.
- Well designed decorative features, externally and/or internally

Historical

A structure may be considered of special historical interest under the following criteria:

- A significant historical event associated with the structure
- An association with a significant historical figure
- Has a known interesting and/or unusual change of use, e.g. a former workhouse now in use as a hotel
- A memorial to a historical event.

Technical

A structure may be considered of special technical interest under the following criteria:

- Incorporates building materials of particular interest, i.e. the materials or the technology used for construction
- It is the work of a known or distinguished engineer
- Incorporates innovative engineering design, e.g. bridges, canals or mill weirs
- A structure which has an architectural interest may also merit a technical interest due to the structural techniques used in its construction, e.g. a curvilinear glasshouse, early use of concrete, cast-iron prefabrication.
- Mechanical fixtures relating to a structure may be considered of technical significance.

Cultural

A structure may be considered of special cultural interest under the following criteria:

- An association with a known fictitious character or event, e.g. Sandycove Martello Tower, which featured in Ulysses.
- Other structure that illustrate the development of society, such as early schoolhouses, swimming baths or printworks.

Scientific

A structure may be considered of special scientific interest under the following criteria:

- A structure or place which is considered to be an extraordinary or pioneering scientific or technical achievement in the Irish context, e.g. Mizen Head Bridge, Birr Telescope.

Social

A structure may be considered of special social interest under the following criteria:

- A focal point of spiritual, political, national or other cultural sentiment to a group of people, e.g. a place of worship, a meeting point, assembly rooms.
- Developed or constructed by a community or organisation, e.g. the construction of the railways or the building of a church through the patronage of the local community
- Illustrates a particular lifestyle, philosophy, or social condition of the past, e.g. the hierarchical accommodation in a country house, philanthropic housing, vernacular structures.

Artistic

A structure may be considered of special artistic interest under the following criteria:

- Work of a skilled craftsman or artist, e.g. plasterwork, wrought-iron work, carved elements or details, stained glass, stations of the cross.
- Well designed mass produced structures or elements may also be considered of artistic interest.

(From the NIAH Handbook 2003 & 2005 pages 15-20)

The Local Authority has the power to order conservation and restoration works to be undertaken by the owner of the protected structure if it considers the building to be in need of repair. Similarly, an owner or developer must make a written request to the Local Authority to carry out any works on a protected structure and its environs, which will be reviewed within three months of application. Failure to do so may result in prosecution.

IMPACT ASSESSMENT AND THE CULTURAL HERITAGE RESOURCE

Potential Impacts on Archaeological and Historical Remains

Impacts are defined as 'the degree of change in an environment resulting from a development' (Environmental Protection Agency 2003: 31). They are described as profound, significant or slight impacts on archaeological remains. They may be negative, positive or neutral, direct, indirect or cumulative, temporary or permanent.

Impacts can be identified from detailed information about a project, the nature of the area affected and the range of archaeological and historical resources potentially affected. Development can affect the archaeological and historical resource of a given landscape in a number of ways.

- Permanent and temporary land-take, associated structures, landscape mounding, and their construction may result in damage to or loss of archaeological remains and deposits, or physical loss to the setting of historic monuments and to the physical coherence of the landscape.

- Archaeological sites can be affected adversely in a number of ways: disturbance by excavation, topsoil stripping and the passage of heavy machinery; disturbance by vehicles working in unsuitable conditions; or burial of sites, limiting accessibility for future archaeological investigation.

- Hydrological changes in groundwater or surface water levels can result from construction activities such as de-watering and spoil disposal, or longer-term changes in drainage patterns. These may desiccate archaeological remains and associated deposits.

- Visual impacts on the historic landscape sometimes arise from construction traffic and facilities, built earthworks and structures, landscape mounding and planting, noise, fences and associated works. These features can impinge directly on historic monuments and historic landscape elements as well as their visual amenity value.

- Landscape measures such as tree planting can damage sub-surface archaeological features, due to topsoil stripping and through the root action of trees and shrubs as they grow.

- Ground consolidation by construction activities or the weight of permanent embankments can cause damage to buried archaeological remains, especially in colluviums or peat deposits.

- Disruption due to construction also offers in general the potential for adversely affecting archaeological remains. This can include machinery, site offices, and service trenches.

Although not widely appreciated, positive impacts can accrue from developments. These can include positive resource management policies, improved maintenance and access to archaeological monuments, and the increased level of knowledge of a site or historic landscape as a result of archaeological assessment and fieldwork.

Predicted Impacts

The severity of a given level of land-take or visual intrusion varies with the type of monument, site or landscape features and its existing environment. Severity of impact can be judged taking the following into account:

- The proportion of the feature affected and how far physical characteristics fundamental to the understanding of the feature would be lost;

- Consideration of the type, date, survival/condition, fragility/vulnerability, rarity, potential and amenity value of the feature affected;

- Assessment of the levels of noise, visual and hydrological impacts, either in general or site specific terms, as may be provided by other specialists.

MITIGATION MEASURES AND THE CULTURAL HERITAGE RESOURCE

Potential Mitigation Strategies for Cultural Heritage Remains

Mitigation is defined as features of the design or other measures of the proposed development that can be adopted to avoid, prevent, reduce or offset negative effects.

The best opportunities for avoiding damage to archaeological remains or intrusion on their setting and amenity arise when the site options for the development are being considered. Damage to the archaeological resource immediately adjacent to developments may be prevented by the selection of appropriate construction methods. Reducing adverse effects can be achieved by good design, for example by screening historic buildings or upstanding archaeological monuments or by burying archaeological sites undisturbed rather than destroying them. Offsetting adverse effects is probably best illustrated by the full investigation and recording of archaeological sites that cannot be preserved *in situ*.

Definition of Mitigation Strategies

Archaeological Resource

The ideal mitigation for all archaeological sites is preservation *in situ*. This is not always a practical solution, however. Therefore a series of recommendations are offered to provide ameliorative measures where avoidance and preservation *in situ* are not possible.

Full Archaeological Excavation can be defined as ‘a programme of controlled, intrusive fieldwork with defined research objectives which examines, records and interprets archaeological deposits, features and structures and, as appropriate, retrieves artefacts, ecofacts and other remains within a specified area or site on land, inter-tidal zone or underwater. The records made and objects gathered during fieldwork are studied and the results of that study published in detail appropriate to the project design’ (IFA 2008).

Archaeological Test Trenching can be defined as ‘a limited programme of intrusive fieldwork which determines the presence or absence of archaeological features, structures, deposits, artefacts or ecofacts within a specified area or site on land, inter-tidal zone or underwater. If such archaeological remains are present field evaluation defines their character, extent, quality and preservation, and enables an assessment of their worth in a local, regional, national or international context as appropriate’ (IFA 2009).

Archaeological Monitoring can be defined as ‘a formal programme of observation and investigation conducted during any operation carried out for non-archaeological reasons. This will be within a specified area or site on land, inter-tidal zone or underwater, where there is a possibility that archaeological deposits may be disturbed or destroyed. The programme will result in the preparation of a report and ordered archive (IFA 2008).

Underwater Archaeological Assessment consists of a programme of works carried out by a specialist underwater archaeologist, which can involve wade surveys, metal detection surveys and the excavation of test pits within the sea or riverbed. These assessments are able to access and assess the potential of an underwater environment to a much higher degree than terrestrial based assessments.

Architectural Resource

The architectural resource is generally subject to a greater degree of change than archaeological sites, as structures may survive for many years but their usage may change continually. This can be reflected in the fabric of the building, with the addition and removal of doors, windows and extensions. Due to their often more visible presence within the landscape than archaeological sites, the removal of such structures can sometimes leave a discernable ‘gap’ with the cultural identity of a population. However, a number of mitigation measures are available to ensure a record is made of any structure that is deemed to be of special interest, which may be removed or altered as part of a proposed development.

Conservation Assessment consists of a detailed study of the history of a building and can include the surveying of elevations to define the exact condition of the structure. These assessments are carried out by Conservation Architects and would commonly be carried out in association with proposed alterations or renovations on a Recorded Structure.

Building Survey may involve making an accurate record of elevations (internal and external), internal floor plans and external sections. This is carried out using a EDM (Electronic Distance Measurer) and GPS technology to create scaled drawings that provide a full record of the appearance of a building at the time of the survey.

Historic Building Assessment is generally specific to one building, which may have historic significance, but is not a Protected Structure or listed within the NIAH. A full historical background for the structure is researched and the site is visited to assess the standing remains and make a record of any architectural features of special interest. These assessments can also be carried out in conjunction with a building survey.

Written and Photographic record provides a basic record of features such as stone walls, which may have a small amount of cultural heritage importance and are recorded for prosperity. Dimensions of the feature are recorded with a written description and photographs as well as some cartographic reference, which may help to date a feature.

APPENDIX E

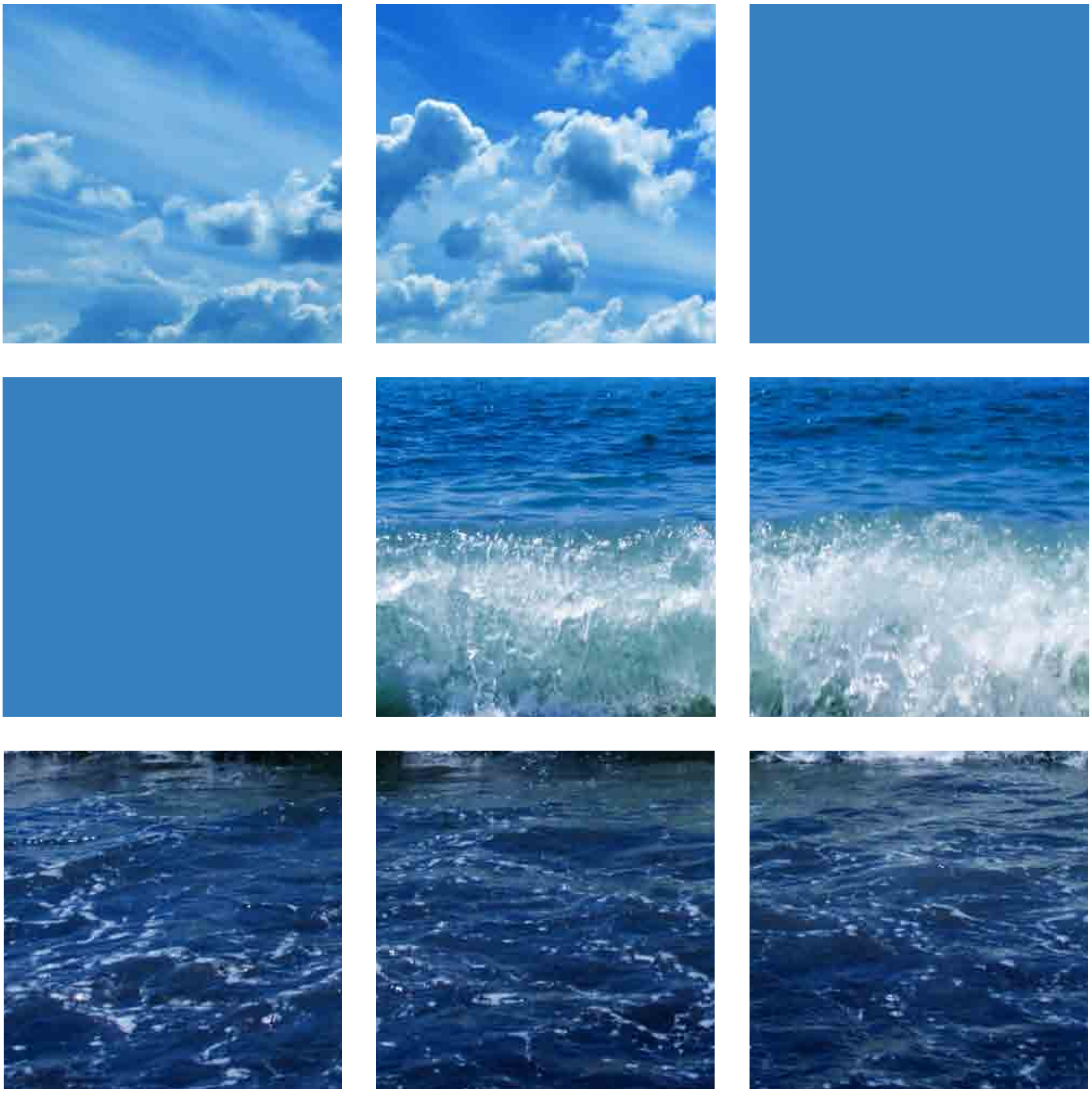
Environmental Modelling

RPS

Environmental Modelling

Dunkellin Flood Alleviation Scheme

IBE0654 R02 Rev01 Sept 14



Environmental Modelling of Dunkellin Flood Alleviation Scheme

DOCUMENT CONTROL SHEET

Client	OPW / Galway County Council					
Project Title	Environmental Modelling of Dunkellin Flood Alleviation Scheme					
Document Title	Salinity Modelling					
Document No.	BE0654/R02/Rev01					
This Document Comprises	DCS	TOC	Text	List of Tables	List of Figures	No. of Appendices
	1	1	17	1	1	0

Rev.	Status	Author(s)	Reviewed By	Approved By	Office of Origin	Issue Date
0	Draft	KC	NS	AKB	Belfast	Mar 2014
1	Final	KC	NS	NS	Belfast	Sept 2014

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1 BACKGROUND

In recent years there have been several significant flood events in the Galway Bay area. Floods were reported in December 1999, January 2005, December 2006 and most significantly in November 2009. As a result of these flood events an alleviation scheme has been proposed for the Dunkellin River, which flows into the Kilcolgan River before entering Galway Bay. However, the latest in the list of these events was caused by substantial rainfall on saturated ground resulted in considerable fresh water discharge into Dunbulcaun Bay; the effect of which was a significant decrease in salinity in the South Bay - this endangered the shellfish and oyster populations in the area. The proposed works to be undertaken on the Dunkellin River channel are designed to convey flood water to the estuary more quickly to alleviate future flooding. This has raised concerns as the increased discharge of fresh water could decrease the ambient salinity to an extent that may potentially impact the shellfish and oyster populations in the event of a similar flood reoccurring.

RPS has been commissioned to carry out an assessment of the increased discharge rate of flood water from the Dunkellin River at Kilcolgan under the proposed scheme by comparing it to the existing conditions. For the study the November 2009 event was used as a basis and it was simulated utilising the available measured flow conditions for the event and also with the altered discharge condition reflecting the impact of the proposed scheme to provide a comparison. Figure 1.1 below shows the location of the main fresh water sources in the Galway Bay Basin.

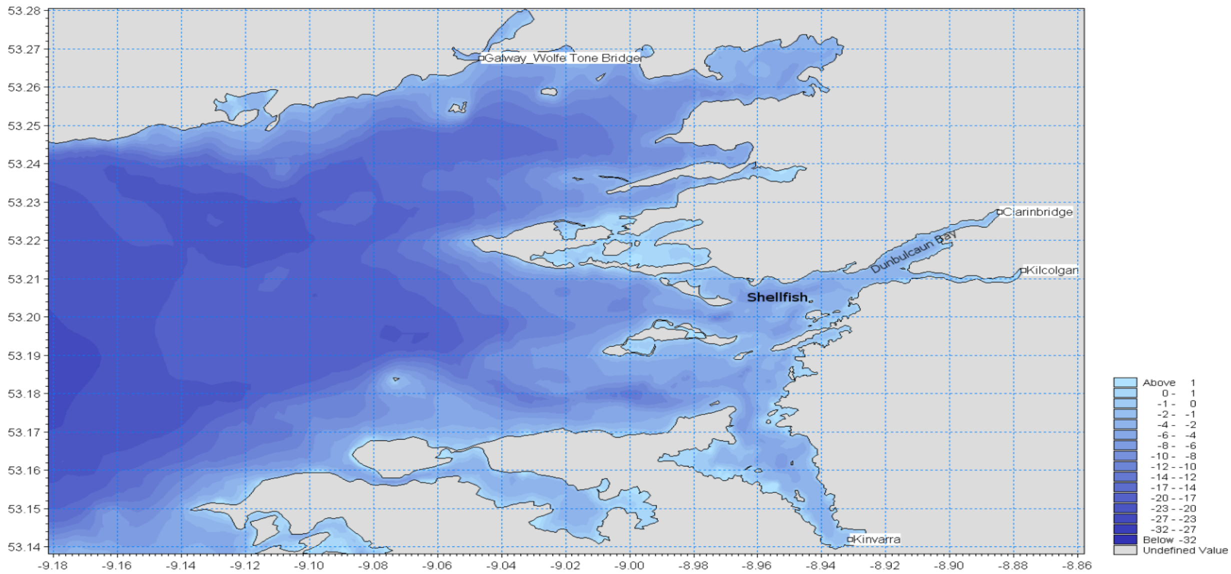

Figure 1.1: Main fresh water sources and Shellfish farm location

2 DATA AND MODELS

2.1 OVERVIEW

The model simulations for the flow regime within Galway Bay were completed using a 3-dimensional MIKE3 HD flexible mesh flow model. The MIKE software is recognised worldwide and used by a number of consultants and research institutions internationally and offers the benefit of enabling the simulation of flows in both two and three dimensions using the same model set-up.

The MIKE 3 HD FM model can be used to simulate a wide range of hydraulic and related processes, including:

- Fluvial flows;
- Tidal exchange with fresh water inflows;
- Heat exchange and re-circulation; and
- Water quality assessments.

The model employed was based on a flexible mesh approach allowing the representation of the area as a combination of triangular and quadrangular cells. The use of flexible mesh technology enables the resolution of the model to be varied spatially over the model domain thus allowing very fine grid resolution to be incorporated where necessary e.g. around the discharge locations and shellfish beds, whilst retaining computational efficiency. The use of the MIKE 3 flexible mesh model permits the incorporation of three dimensional effects i.e. density dominated plume behaviour and stratification. For this study the model was deployed with the vertical water column split into three layers, equally distributed over the full water depth.

The boundary conditions used for this study were water levels applied at the entrance to Galway Bay. These were extracted from the RPS Storm Surge Forecast model, which covers the seas around the island of Ireland and has been calibrated at numerous locations across the domain. The extent of the model used in this study and the bathymetry are shown in Figure 2.1 below:

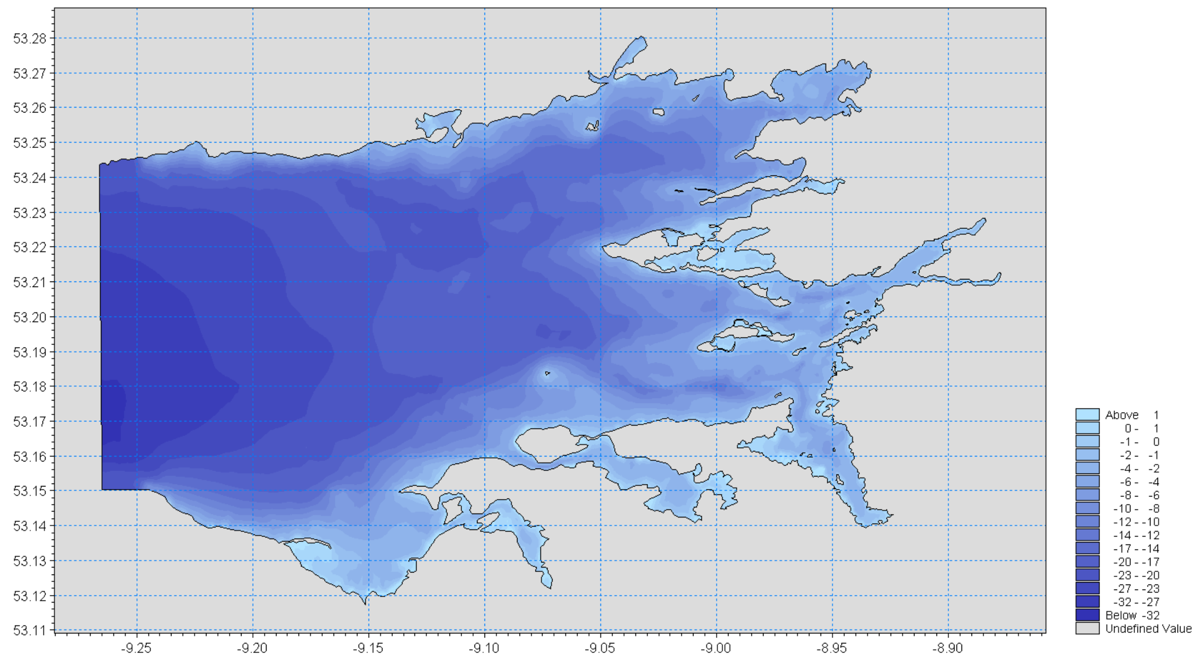

Figure 2.1: Galway Bay model Extent and bathymetry

The bathymetry datum for the model was mean sea level, which varies depending on the location but is 2.86m above chart datum at Galway. The source of the bathymetric data was the latest survey and Lidar data provided by INFOMAR which extended across the entire domain. The following section outlines the ambient conditions which were established as part of the study.

2.2 AMBIENT TIDAL AND FLOW CONDITIONS

The study was required to establish the salinity levels in the shellfish area in the event of extreme fresh water discharge into the Inner Galway Bay. For this study the period of 18 October to 30 November 2009 was examined; incorporating a range of both spring and neap tidal ranges and the flood event itself. The model was run for a prolonged period with mean river discharges prior to this in order to establish the background salinity levels within the Bay. It should be noted that this was a comparative study and calibration data was not available for this study.

River discharges were not available for all freshwater sources within the model domain; OPW operate a number of gauges in the Galway Bay area however this does not provide a complete description of the fresh water flows into the Bay. In the model it was assumed that the Galway Bay had four significant sources of fresh water. The largest of these is the Corrib

River which has an average flow of 99m^3/s and the river discharge applied within the modelling was estimated on the basis of catchment characteristics. The source is located in Galway therefore fluctuations in discharge have a less significant impact on the salinity in the South Bay under the modelling conditions used, which did not include north or north-westerly wind conditions. The second discharge included was the Clarinbridge River, a small river at the North to the Dunbulcaun Bay with annual mean flow of 2.0069m^3/s measured at Station 29004 (Source: OPW website). The third influx was from the Kilcogan / Dunkellin River catchments with a mean annual flow of 6.731 m^3/s (Stn. 29011: Kilcogan). The final source of fresh water is ground water discharge in Kinvarra located to the South of the Kinvarra Bay. In 2011 Cave & Henry examined the relationship between river flows and groundwater flows in their paper 'Intertidal and submarine groundwater discharge on the west coast of Ireland'. They determined that the ground water discharge from Kinvarra was in the order of 10-30% of the discharge from Corrib River; with the proportion increasing with flow rate.

The only parameter to be varied between the two modelled scenarios was the discharge rate from the Kilcolgan River, which allowed the impact of the flood alleviation scheme to be determined accurately. The tidal elevation driving the model at the western boundary was derived from RPS' ICPSS model (see Figure 2.2).

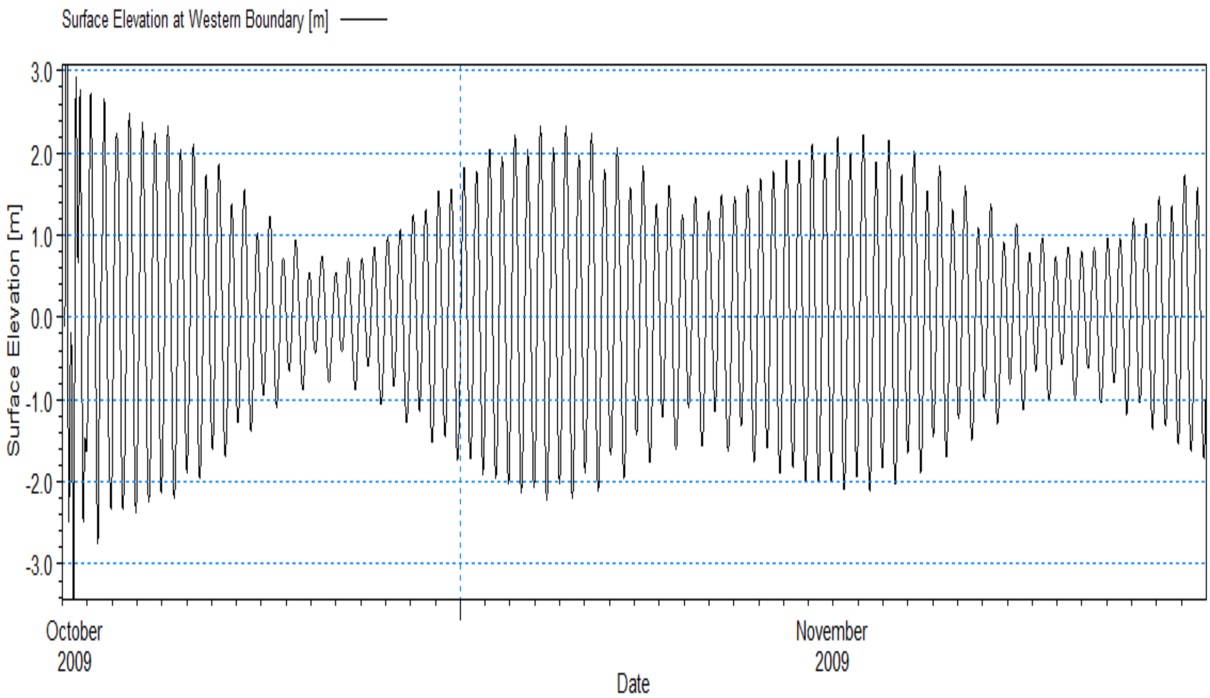

Figure 2.2: Tidal elevation inside Galway Bay.

The mean spring tidal range is approximately 4.5m whilst the mean neap range is 1.9m, as illustrated in Figure 2.3 a & b respectively. This gives rise to a large range in current velocity therefore significant mixing was expected within the Bay.

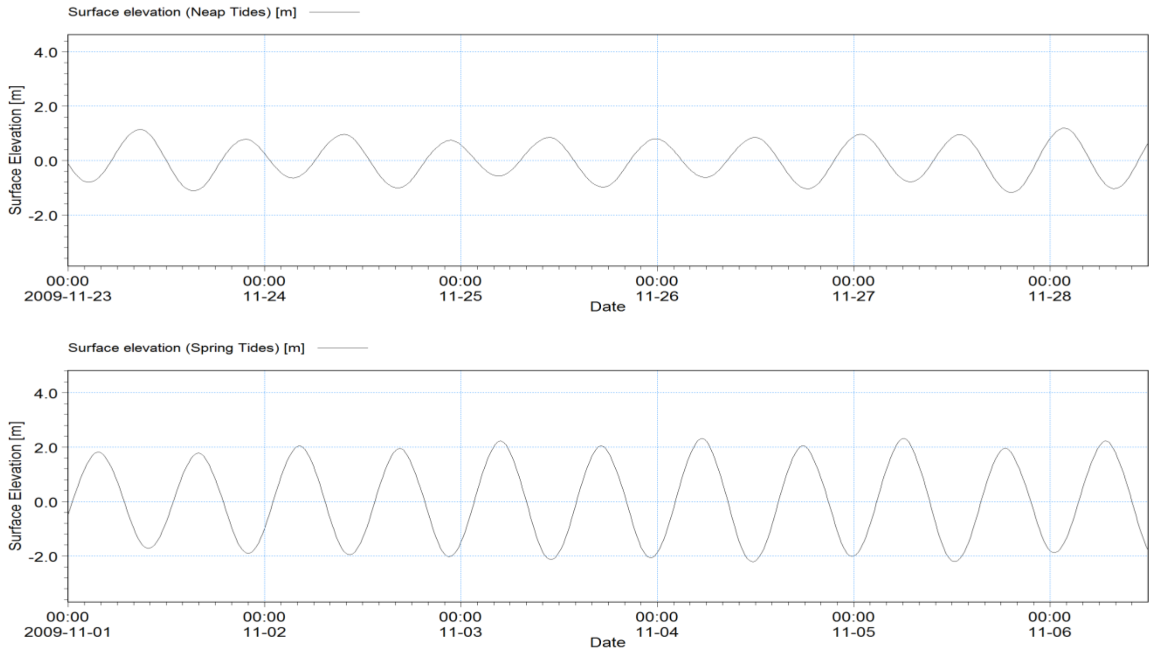

Figure 2.3: Surface elevations during Neap (upper) and Spring (lower) tides

Typical tidal conditions in Galway Bay are presented below with current speed on flood and ebb shown in Figure 2.4 and Figure 2.5 respectively.

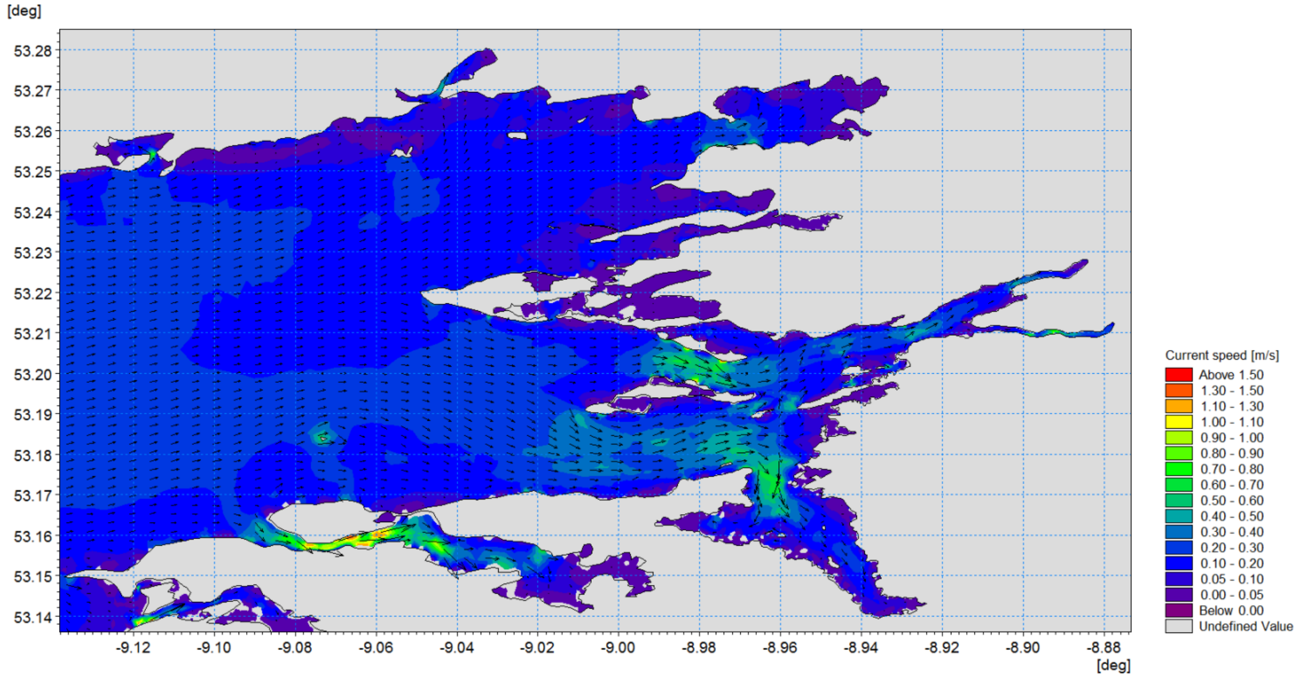

Figure 2.4: Current velocities during a typical spring flood tidal regime

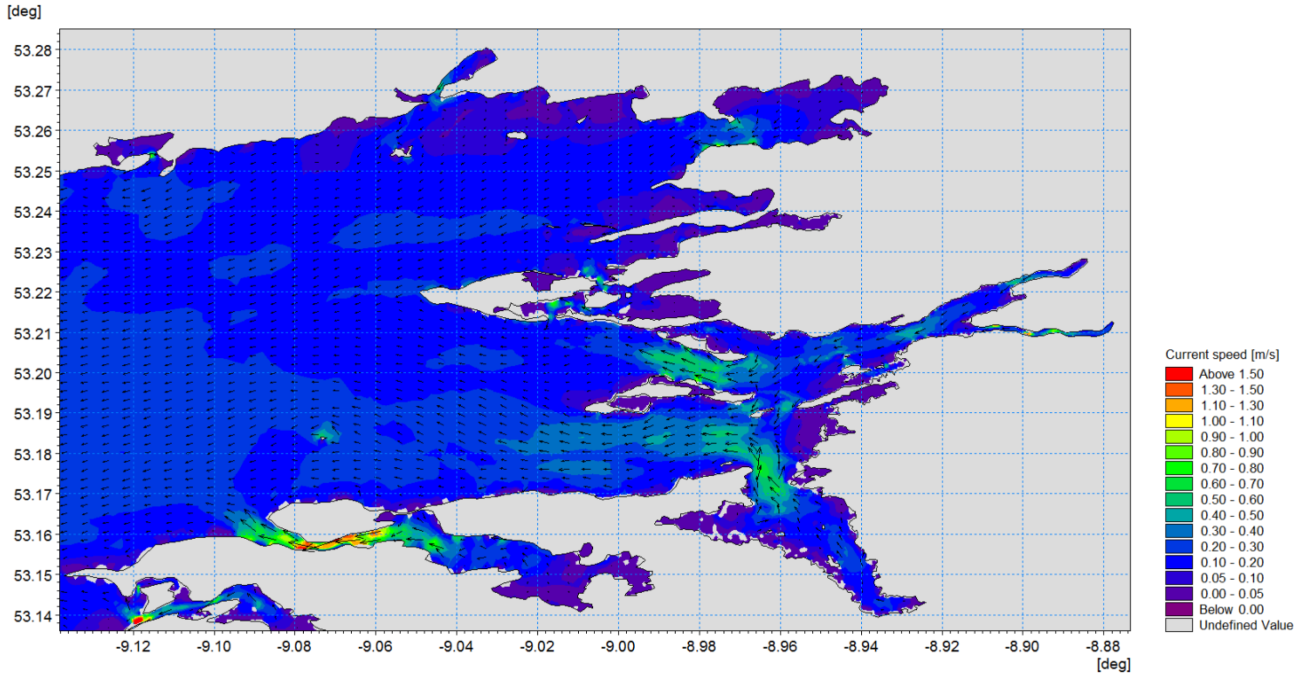

Figure 2.5: Current velocities during a typical neap flood tidal regime.

2.3 DISCHARGE PARAMETERS AND CLIMATIC CONDITIONS

The flooding event in November 2009 was preceded by a very wet summer period which resulted in increased soil saturation. During November a series of Atlantic depressions and their associated fronts moved across Ireland and resulted in unsettled weather, with Galway Bay experiencing 300% of the average rainfall for November. Consequently, the level of some feeding rivers reached their highest recorded water levels, with the heaviest rain being recorded on the 9th, 16th to 19th and again on the 21st of November.

The fresh water discharges peaked on the 21st of November and was followed by a relatively rapid decline in precipitation. Figure 2.6 shows the Corrib River discharge and the calculated Kinvarra groundwater flow into Galway Bay during November 2009.

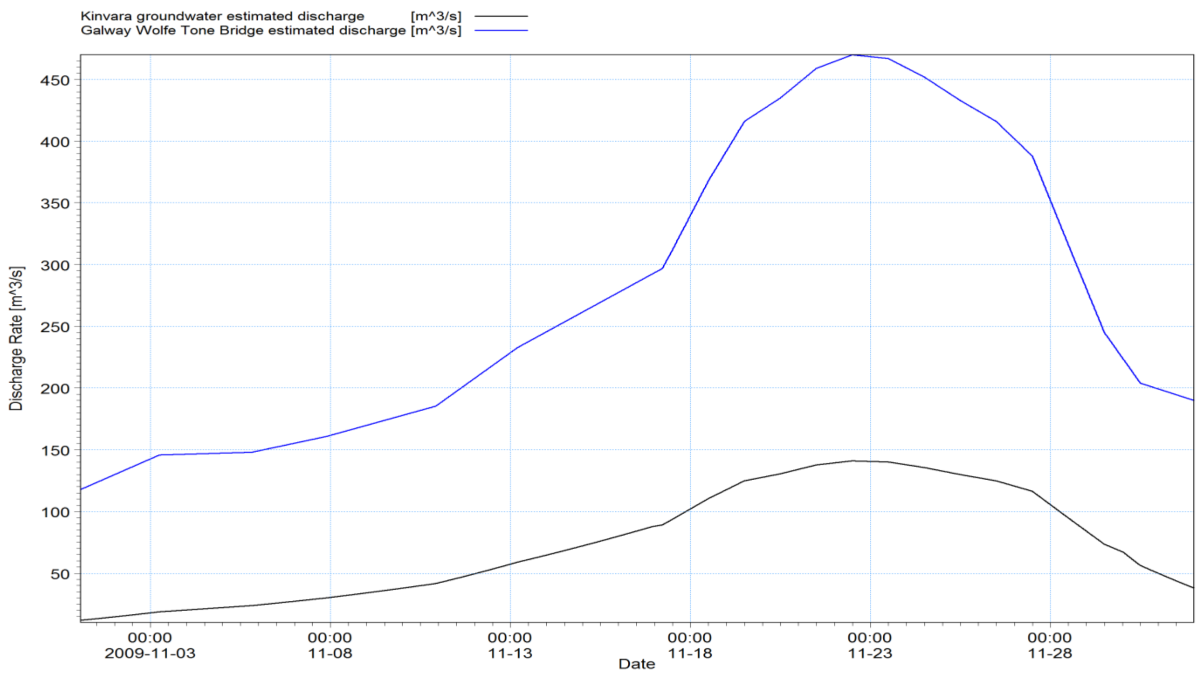

Figure 2.6: Corrib River discharge and the calculated Kinvarra groundwater flow

The two rivers with greatest importance in this study are Clarinbridge and Kilcogan as they both discharge to Dunbulcaun Bay. It can be seen from Figure 2.7 that the peak discharge recorded downstream at Kilcolgan on 21st November 2009 is approximately 79 m^3/s and the Clarinbridge discharge reaches 20 m^3/s in the same period.

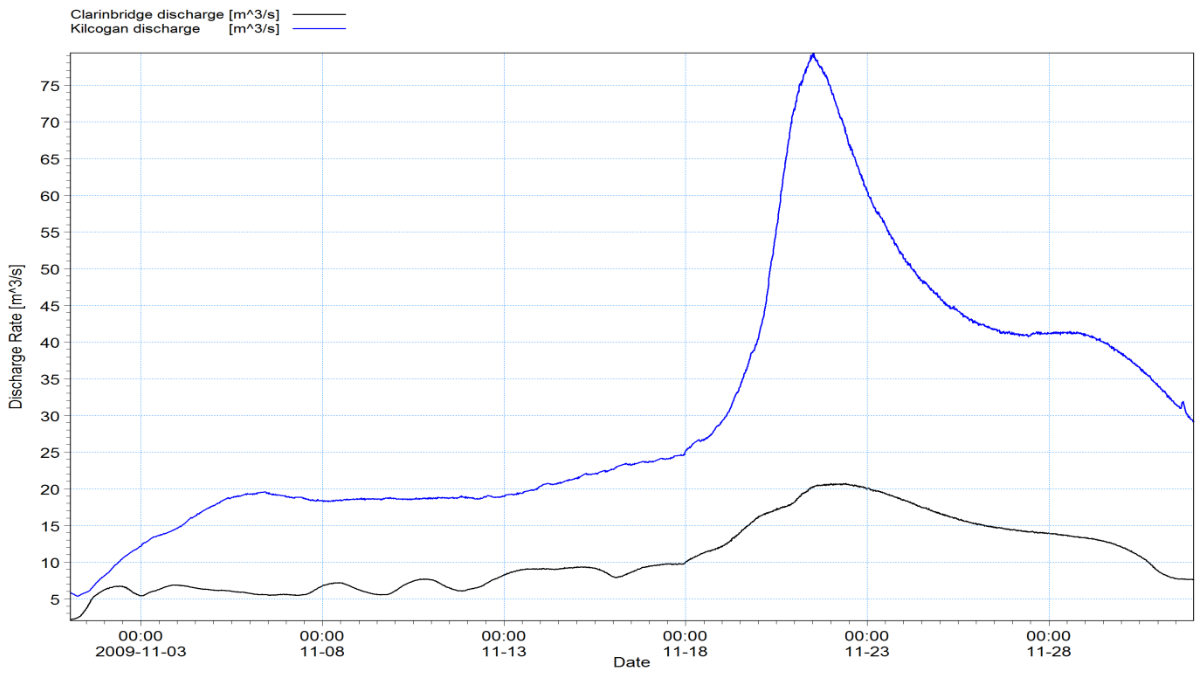

Figure 2.7: Discharge rates from Clarinbridge River and discharge at Kilcolgan

The predicted implication of the scheme on fresh water discharge rates during this event was assessed by Tobin Consulting Engineers in "Dunkellin & Aggard Stream Flood Relief Scheme Technical Description for EIS" report dated January 2014, who concluded that the proposed scheme will increase the peak discharge rate into Galway Bay by 1%. The time to peak flow (T_p) was also estimated to be reduced from 95 hours to 93 hours. Figure 2.8 below illustrates the change to the hydrograph at Kilcolgan for this event.

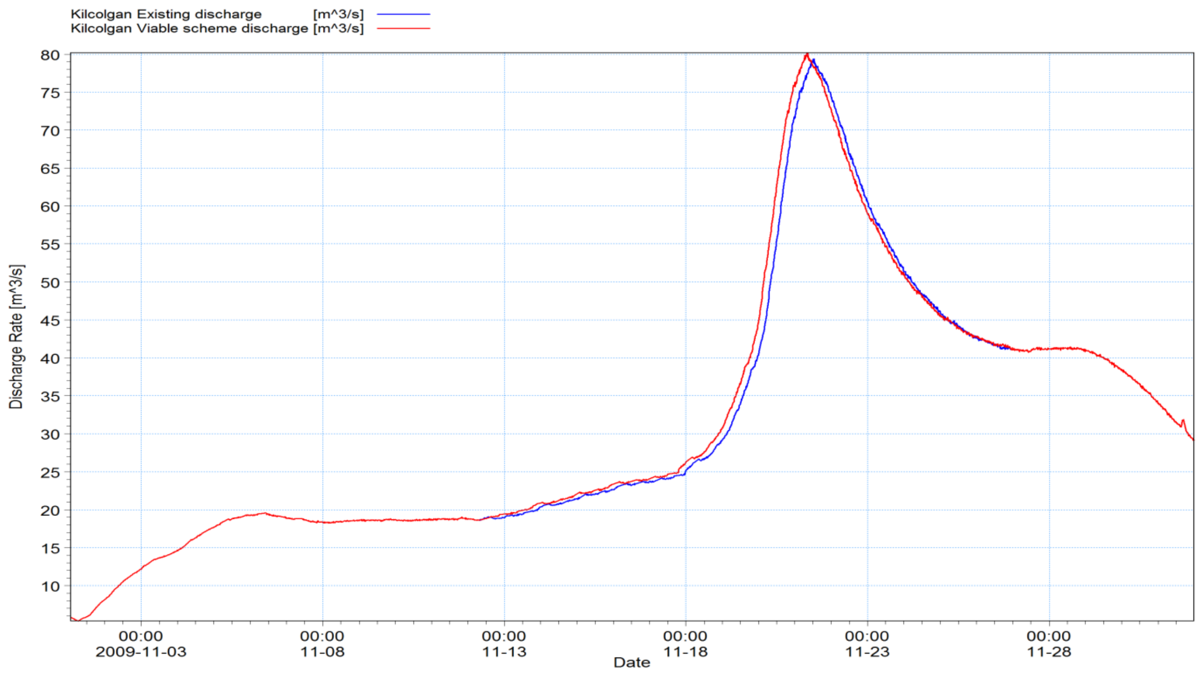

Figure 2.8: Kilcolgan hydrographs: existing (blue) and proposed Dunkellin Scheme (red)

The event in November 2009 was of significant importance to the shellfish beds because of the timing of the peak flow in relation to the tidal state. Although the elevated discharge rates persist for several days, the peak discharge rate was observed during low water. This meant that the shellfish community were at their most vulnerable as the following flood tide prevented this significant volume of fresh water from leaving the Bay. This was exacerbated by a neap tidal regime which further reduced the flushing of Dunbulcaun Bay.

Despite the peak discharge rate of the Kilcolgan River during the November flood event occurring concurrently with a neap low tide, it should be noted that each particular flood event will have a different potential impact on the shellfish beds depending on the phasing of tidal cycle at the time of each particular flood event. Correspondingly, the effect of the impact of the scheme may vary; this comparative study examined only one such event. Prevailing wind conditions may also be of significance during such events.

3 MODEL RESULTS

3.1 EXISTING SCENARIO

The modelling was used to determine the distribution of salinity within the Bay with the measured discharge from Kilcogan during the November 2009 event. As previously discussed, the background salinity and inflows were representative of the period however detailed measurements were not available at the time of modelling and meteorological conditions were not included within the modelling. Figure 3.1 shows the salinity variation across the extent of Galway Bay at low water when the peak Kilcogan River discharge reaches the shellfish site, 14:15pm on 21st November; at this time some of the lowest salinities were experienced. The influx of freshwater from the various sources is visible within the Bays, with the salinity gradient extending to a fully mixed condition at a considerable distance from the inner bays.

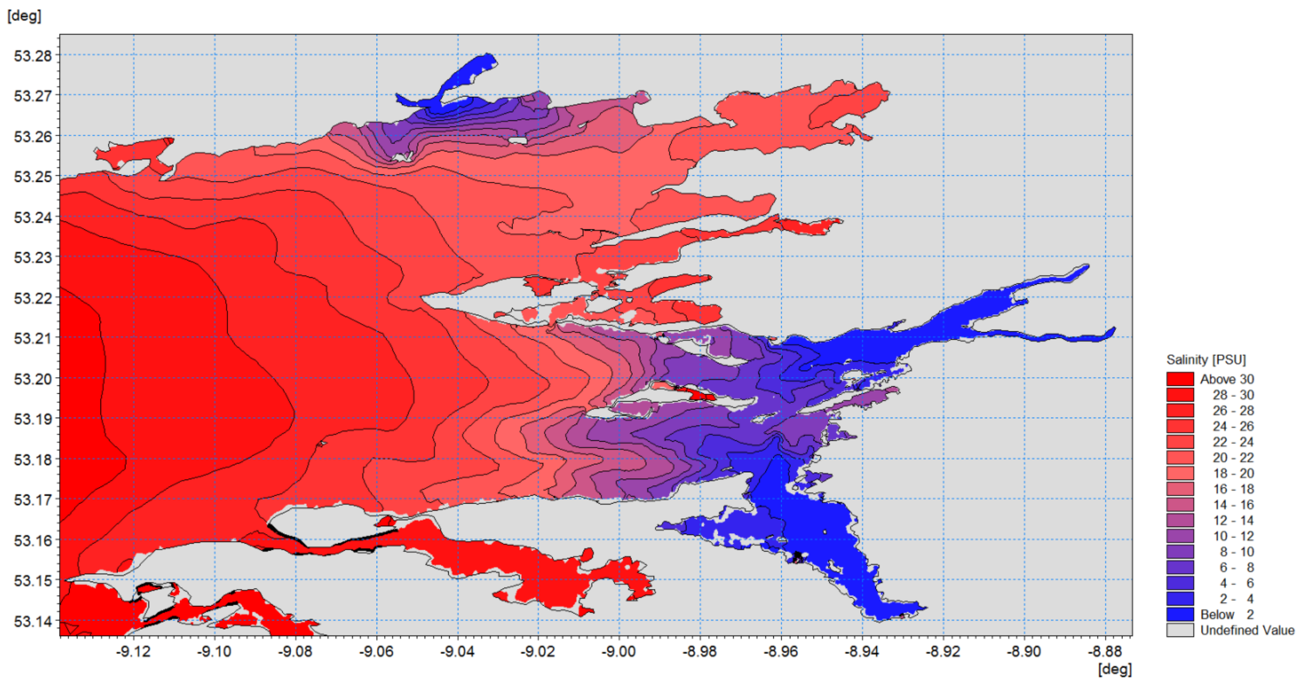

Figure 3.1: Salinity bed layer - low water with peak river flows – 14.15pm 21st Nov 2009

The variation in salinity over the flood event period was examined in relation to the vertical mixing and potentially stratified flows. Data for a location within the shellfish beds at Lynch's Quay, Ballinacourty, 8° 57.32' W, 53° 12.39' N, is depicted in Figure 3.2. In the lower traces the salinity at the bed layer is shown in blue and the surface layer in red, whilst the tidal excursion is presented in black in the upper trace. It may be seen that the salinity can vary significantly within the Bay over the course of the tidal cycle; typically the salinity at the shellfish site varies between 3 and 22 PSU. The vertical mixing is also a significant factor; with a maximum difference of <3 PSU across the water column, the mixing is most apparent during high water spring tides where the fluids are fully mixed and, as expected, the vertical mixing is reduced during neap tides.

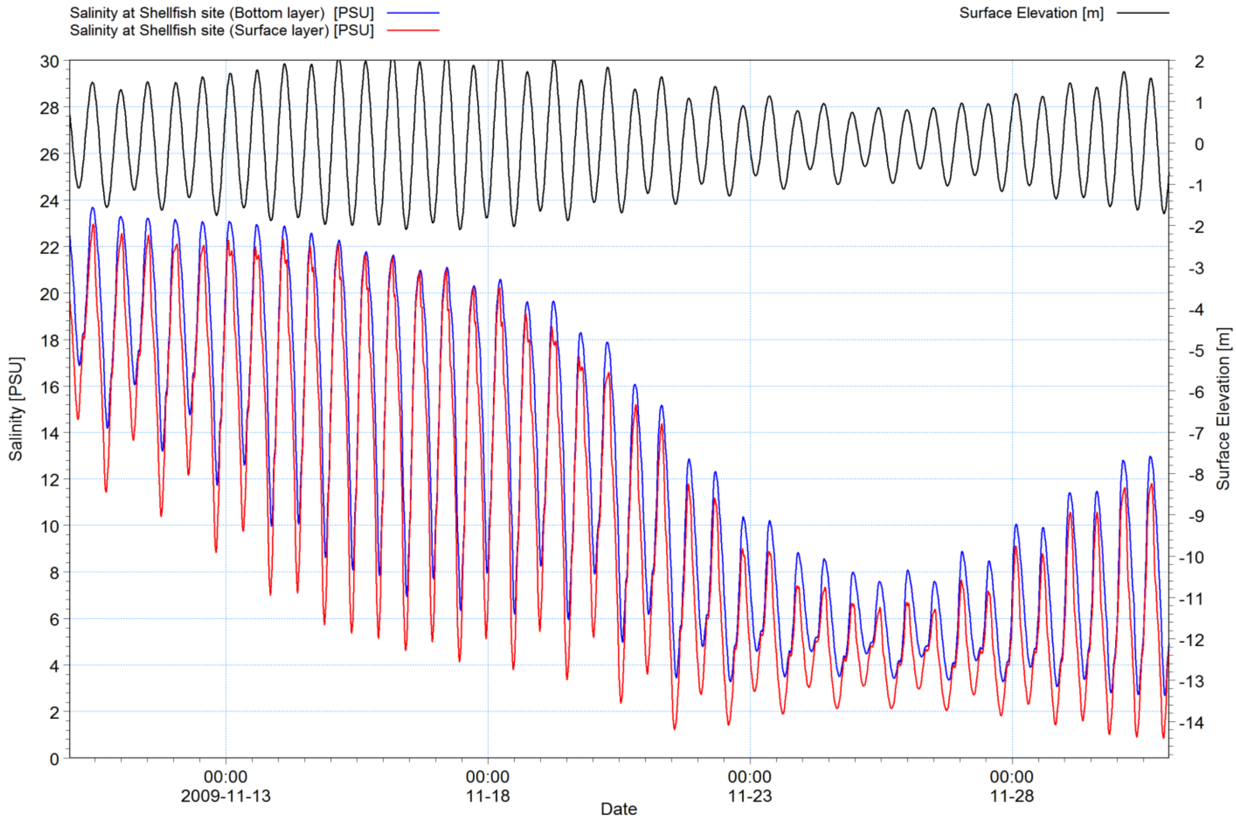

Figure 3.2: Salinity in the bottom (blue) and surface (red) layers and surface elevation at the shellfish site.

3.2 FLOOD ALLEVIATION SCHEME

The simulation was re-run with the amended hydrograph at the Kilcogan source; the same background levels and freshwater flows were used in order to provide true comparison between the scenarios; with and without the scheme in place. By way of comparison the same time step was extracted from across the model domain and is illustrated, in greater detail, in Figure 3.3 with the difference between the two scenarios shown in Figure 3.4.

The detailed salinity gradient plot, Figure 3.3, has a reduced palette and shows that the South Bay is typically below 12 PSU and at the Ballinacourty shellfish site it is around 3 PSU. However, when the following difference plot is considered it can be seen that the change in salinity across the entire South Bay is typically less than ±0.5 PSU at this time for the two scenarios. It should be noted that the flood alleviation scheme conveys the freshwater discharge slightly more quickly but the total discharge is not increased over the course of the event.

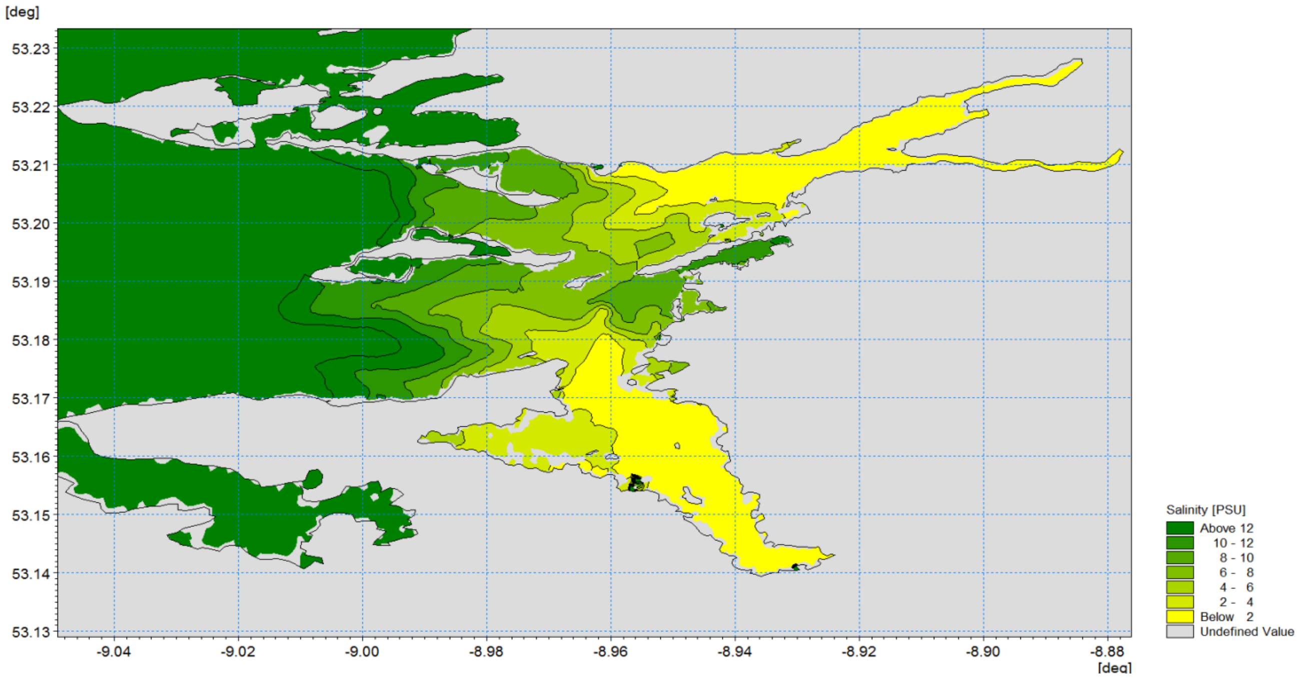

Figure 3.3: Salinity, bed layer with the Dunkellin Scheme – 14.15pm 21st November 2009

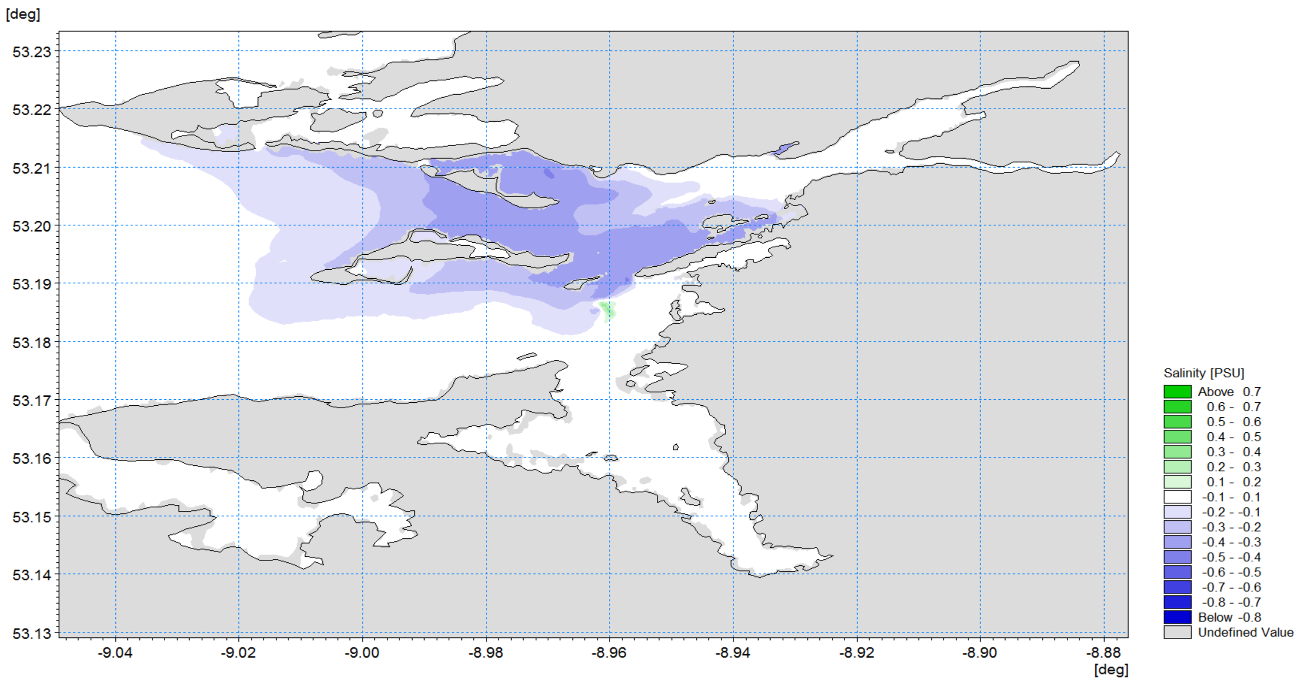

Figure 3.4: Salinity difference (proposed minus existing) –14.15pm 21st November 2009

In order to provide a balanced comparison, rather than a 'worse case snapshot' the effect of the scheme on the shellfish beds was investigated over the period of the event. All licensed sites in the vicinity were analysed as illustrated by the red hatched areas in Figure 3.5. The site at Lynch's Quay was found to be representative of the most affected areas and is presented in more detail. Figure 3.6 and Figure 3.7 show the salinity comparisons at this location for the model period and in detail over peak discharge period respectively. It may be seen that the change in the hydrograph due to the flood alleviation scheme has a virtually undetectable impact on the salinity variations at the shellfish beds. The greatest difference is approximately 0.15 PSU which occurs immediately following the peak flow; the hydrographs shown on the detailed plot demonstrate this.

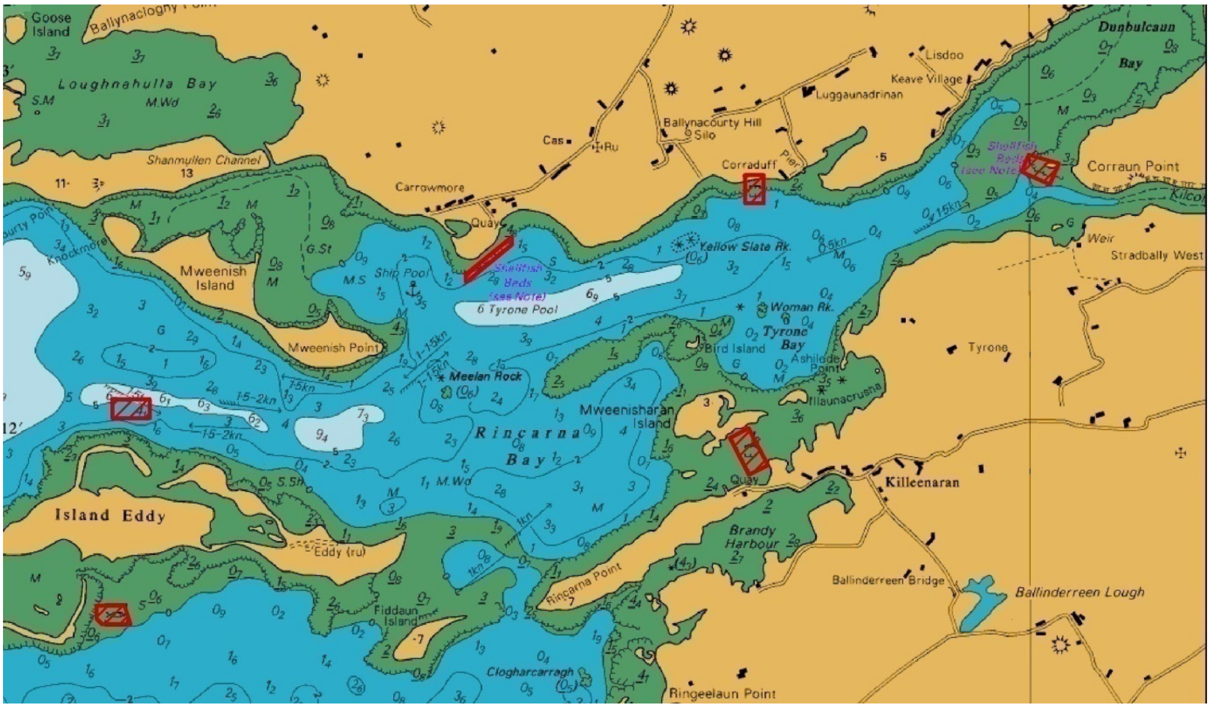

Figure 3.5: Licensed aquaculture sites - red hatched areas

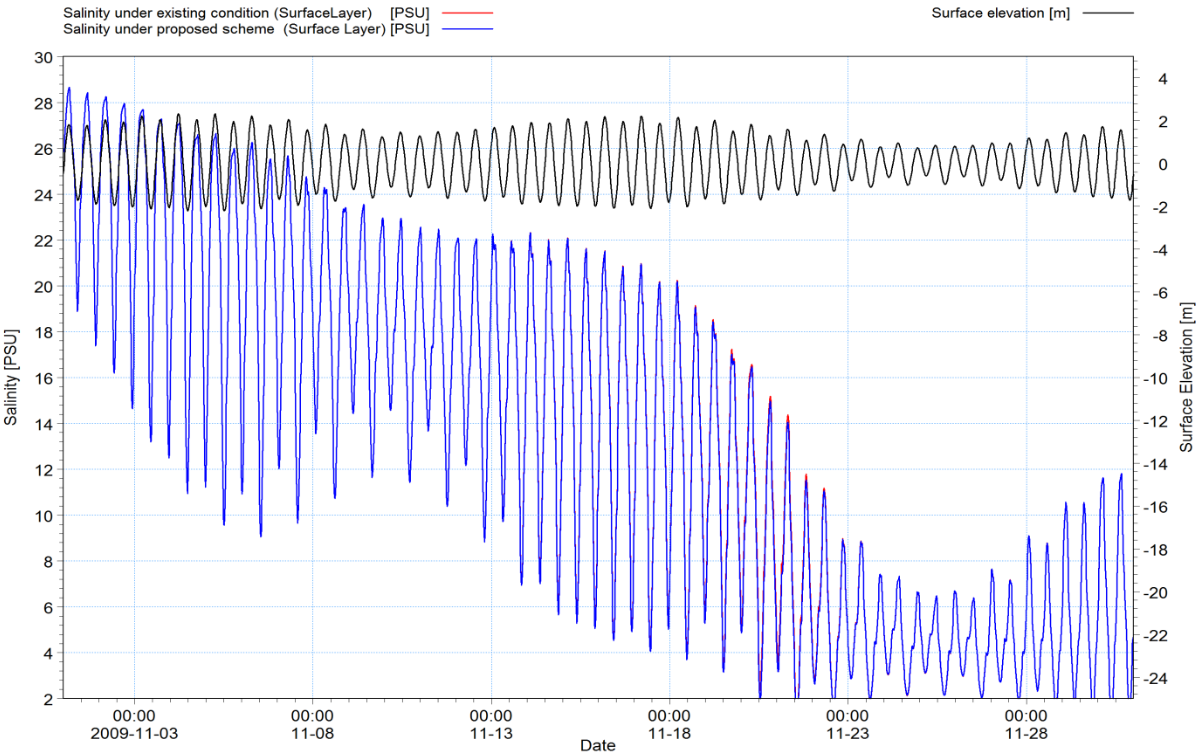

Figure 3.6: Salinity variation at Lynch's Quay during November 2009 under existing conditions and under proposed flood alleviation scheme

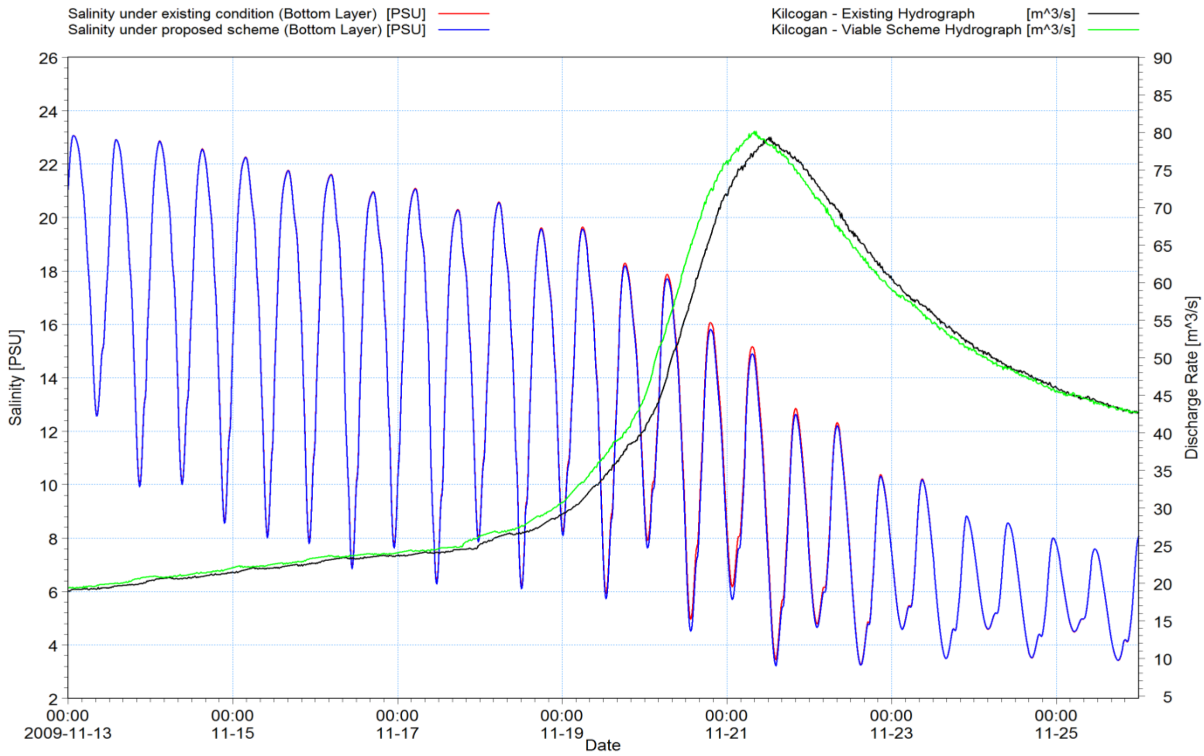

Figure 3.7: Detail of peak flow period under existing conditions and under proposed flood alleviation scheme at Lynch's Quay

4 SUMMARY AND CONCLUSIONS

A comparative study was carried out using 3D modelling techniques to examine the impact of the proposed Dunkellin flood alleviation scheme on shellfish in the South Bay. The November 2009 event was used as a basis as it was a period when oyster beds were exposed to prolonged low salinity conditions which, if worsened, would have resulted in significant mortality in the shellfish.

The modelling demonstrated that, for this event, the salinity levels at the shellfish beds would experience minimal effects due to the alleviation scheme. The change in the salinity from the actual event was of much less than 1 PSU reduction which existed only for short periods over a few tides. Following this period there was no discernible differences between the scenarios. Analysis of this event showed that relatively small changes in peak flow due to the scheme will have minimal impacts particularly when compared with the effect of the timing of flood events in relation to the tide, lunar cycles and wind conditions; which would have a far greater bearing on shellfish mortality.

5 REFERENCES

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Tobin Consulting Engineers. (2014). Dunkellin River & Aggard Stream Flood Relief Scheme: Description of the proposed works. *Galway County Council,* 61.

NUI Galway
OÉ Gaillimh

Review of updated report on Dunkellin River and Aggard Stream Flood Relief Scheme.

The initial (2012) report showed a 13% increase in peak discharge if the flood alleviation scheme is implemented and a 2009 type flood event occurred, and increases of around 20% in discharges in the three days before the peak. Originally the widening works for the Dunkellin were envisaged to go from the Rahasane Turlough all the way to the sea at Kilcolgan. The current proposal has removed two large section of widening works: (1) between Dunkellin Bridge and Rinn Bridge, and (2) between Rinn bridge and the Rahasane Turlough. In the revised model, the 2014 report shows the peak discharge under the same conditions has gone down to 1% and indicates increases in discharge over the three days before the peak of around 10% compared to the 2009 flood. Increases in discharges at Lynch's Quay of between 3% and 5% are indicated over three days preceding the peak.

Under flood conditions without the flood alleviation scheme, at discharge rates of ~20 m3/s, salinity at low spring tide gets below 12 (the critical values for shellfish waters), with the period of time during a given tidal cycle at which the salinity remains below 12 increasing as tides move towards neaps and the discharge increases to ~80 m3/s. Salinity remains below 12 over full tidal cycles over several days at neaps even as the discharge declines from its peak. Shellfish can survive for short periods in water of salinities below 12, but not for such extended periods.

With respect to the updated model, I stand by my original opinion that under the same flood conditions as experienced in 2009, the flood alleviation scheme will not worsen conditions for shellfish in the bay.

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Date: 24th September 2014

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