



OFFICE OF PUBLIC WORKS

REVIEW OF THE SOUTH GALWAY FLOOD STUDY REPORT

ASSESSMENT OF THE EXISTING KILTIERNAN / BALLINDERREEN FLOOD RELIEF SCHEME

FINAL – NOVEMBER 2010

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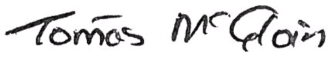

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1. INTRODUCTION & BACKGROUND / HISTORICAL FLOODING EVENTS

1.1 INTRODUCTION

Jennings O'Donovan & Partners (JOD) were appointed in July 2010 by the Office of Public Works (OPW) as Consulting Engineers to Review the recommendations of the South Galway Flood Study Report dated April 1998. Included in the brief was the review of proposed engineering improvement and maintenance works on the existing privately constructed Kiltiernan/ Ballinderreen Scheme which is the subject of this report.

1.2 SCOPE OF WORKS

This report focuses on Item 1.5 of the Scope of Works agreed between OPW and JOD which requires JOD to carry out the review of the existing privately constructed Kiltiernan / Ballinderreen Emergency Flood Relief Scheme. The specific requirements for JOD as outlined in Item 1.5 of the Scope of Works are as follows:-

- “Site Inspection, walk route of existing channel.
- Assess condition of existing channel, assess condition of existing bridges along route, assess conditions and level of bridge on Ballinderreen Road.
- Carry out hydrological assessment of existing channel and outline proposal, make recommendations for pipe sizing if appropriate.
- Consider replacement of any uneven pipelines.
- Preparation of report and recommendations for engineering improvement works and maintenance works with outline drawings as necessary to support any engineering improvement works proposed.
- Preparation of cost estimate for improvement works / maintenance works proposed.
- Identification of environmental constraints, if any.”

In this report, JOD assesses the conditions of the existing Kiltiernan and Ballinderreen channels and proposes a range of maintenance works with the objective of restoring natural flow conditions.

1.3 BACKGROUND / HISTORICAL FLOODING EVENTS

Both channels were privately constructed in 1995 as part of emergency flood relief works and a number of structural / hydraulic issues have been identified by the OPW and local residents. The above issues are further investigated in this report.

Based on the information on flooding available on the OPW website www.floodmaps.ie, there are records in relation to historic flood events in the Kiltiernan and Ballinderreen areas :

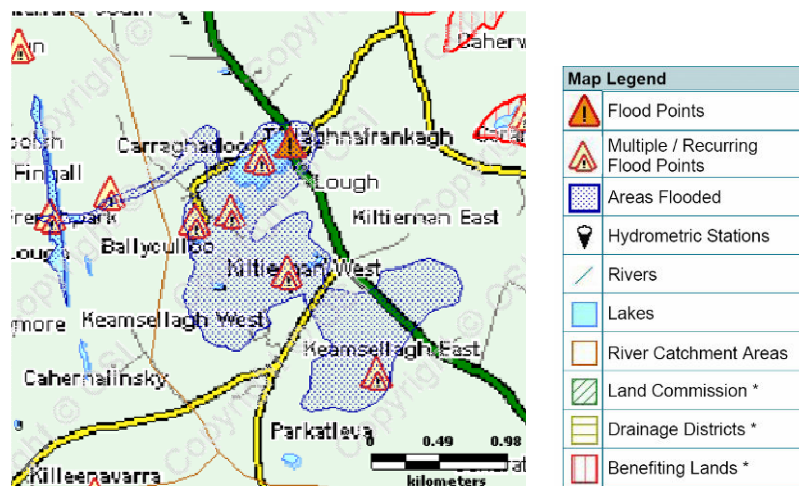


Figure 1.1 : Kiltiernan Area



Figure 1.2 : Ballinderreen Area

As can be seen above, large areas within the catchment are prone to flooding. And although emergency works were carried out in 1995, the flood risk remains and flood waters were particularly high in November 2009 as shown in the aerial photographs in Figures 1.3 and 1.4.



*Figure 1.3 : Tullaghnafrankagh / Caheradoo
Flood Area
November 2009*



*Figure 1.4 : Kiltiernan School / Keamsellagh
Flood Area
November 2009*

2. DATA AVAILABLE AND METHODOLOGY USED

2.1 COLLECTION OF DATA

Information on historic flood events within the Kiltiernan / Ballinderreen Area was sourced from the OPW National Flood Hazard Mapping website (www.floodmaps.ie) as well as from the following studies and surveys :

- An Investigation of the Flooding Problems in the Gort – Ardahan Area of South Galway – April 1998 Final Report
- Kiltiernan & Ballinderreen Flood Relief Scheme – Preliminary Design 1995 – Tobin Consulting Engineers
- Ballinderreen / Kiltiernan Survey Results – 2000 – OPW
- A Report on the Flooding in the Gort – Ardahan Area – January 1992 – Geological Survey of Ireland
- Report on Flooding in South Galway in 1994 – May 1994 – OPW
- Galway Bay LIDAR Surveys carried out by INFOMAR in 2006 and 2008
- Report on the November 2009 rainfall in Ireland – Met Eireann website (www.met.ie)

Aerial photographs of the November 2009 flood as well as the mid and late 1990s floods in the study area were also provided by the OPW.

The layout of the future M18 motorway between Gort and Tuam was also considered. The layout is shown on Drawing No. 4721/KB/13 and the impact of the motorway on the scheme is assessed under Section 5.2.4.

2.2 METHODOLOGY

In addition to the data collected from previous studies and surveys as outlined above, JOD carried out a detailed topographical survey of the Kiltiernan and Ballinderreen channels

using a GPS ProMark 500. The survey was carried out between the 23rd of August 2010 and the 27th of August 2010. The following was recorded :

- **Invert levels**
- **Left and right banks levels**
- **Channel cross sectional geometry**
- **Bridges and culverts geometry**
- **Condition of the channels (blockages, structural restrictions and over grown areas)**

The above data was subsequently processed and detailed longitudinal sections were produced and compared with the OPW longitudinal section dated 2000 to identify any changes in the geometry of the channels.

The geometric data then provided the basis for the calculation of the existing flow capacity of the various sections of the channels as well as the various culverts and bridges. A detailed assessment of the flows was carried out in order to determine the restrictions in capacity for all sections of the channels.

Upgrade works were subsequently defined for all or part of the channels as follows :

- **Cleaning of the bed and banks**
- **Regrading Works where backflows or insufficient capacity were identified**
- **Relaying of part of the underground sections (piped or culverted)**
- **Replacing / upsizing / strengthening of culverts and bridges**
- **Possible alternative Flood alleviation routes**

3. ASSESSMENT OF THE EXISTING KILTIERNAN CHANNEL

The Kiltiernan and Ballinderreen channels were both privately constructed by local residents, farmers and landowners in the mid-1990s as part of emergency flood relief works.

Drawing 4721/KB/01 attached as Appendix A shows the location of both channels.

The Kiltiernan system discharges surface water to Lough Fingall which is surrounded by large flood plains extending up to the townlands of Muggaunagh and Carton located adjacent to the village of Ballinderreen. The Ballinderreen channel is located downstream from the Lough Fingall and surrounding flood plains system.

3.1 CHANNEL ALIGNMENT DESCRIPTION¹

The horizontal alignment of the channel is shown on Drawing 4721/KB/02 attached as Appendix A. The vertical alignment is shown on Drawings 4721/KB/05 and 4721/KB/06.

At its upstream end, the Kiltiernan channel is an open ditch approximately 800 to 1200mm wide at the base and 800 to 1100mm deep. The open ditch runs along the N18 and up to the Kiltiernan school where the channel was piped using 600mm diameter concrete pipes.

¹ All photographs in this section were taken by the OPW following the November 2009 floods



Figure 3.1 : Area surrounding Kiltiernan School – November 2009

The 600mm pipes discharge into an open ditch which crosses under a local road via a 600mm diameter steel pipe. The steel pipe discharges into an overgrown area adjacent to a flood plain known as Keamsellagh Flood.



Figure 3.2 : Keamsellagh Floods Area – November 2009

Under flooding conditions, when water levels rise significantly (refer to the longitudinal section), flood waters are transferred to Tullaghnafrankagh Lough via a 446m long concrete pipe 600mm in diameter.

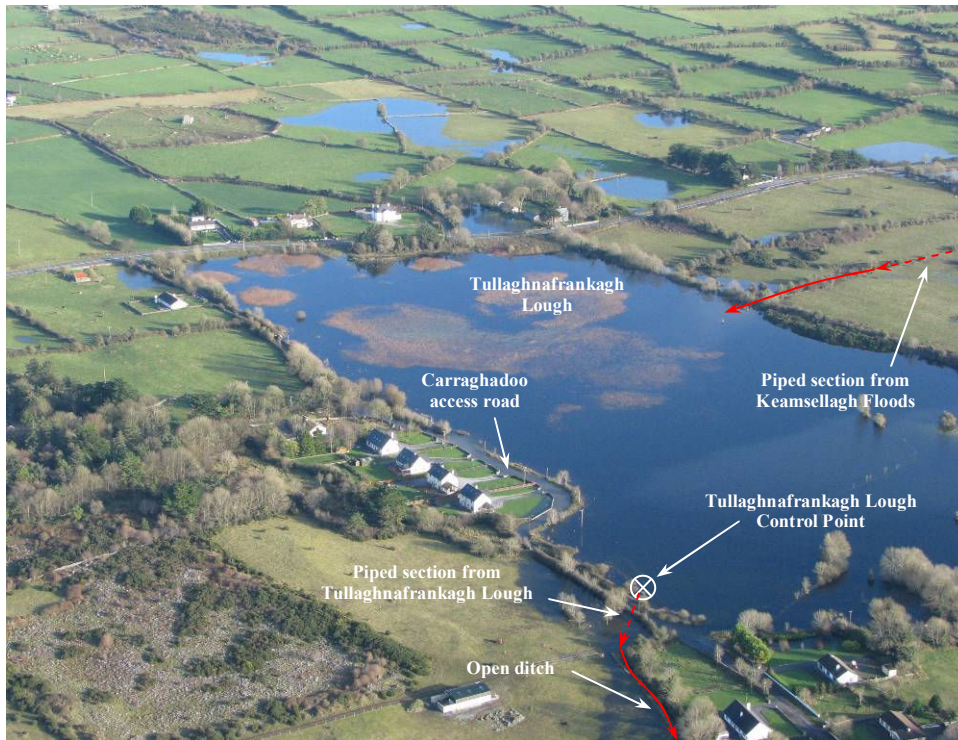


Figure 3.3 : Tullaghnafrankagh Lough – November 2009

On the outlet from Tullaghnafrankagh Lough there is a high level overflow control point allowing flood water to be transferred to Lough Fingall. This control point is located adjacent to a local road serving a number of houses in the Carraghadoo area.



Figure 3.4 : Tullaghnafrankagh Lough / Carraghadoo village – November 2009

Twin 600mm diameter pipes cross under the local road on the outlet to Tullaghnafrankagh Lough and discharge into an open ditch 1200 to 1800mm wide at the base and 600 to 1200mm deep. The drainage system continues underground via twin 600mm diameter pipes initially, changing to a 800mm high by 1500mm wide culvert. The culvert discharges into an open ditch leading to the Lough Fingall flood plains.



Figure 3.5 : Downstream from Carraghadoo village – November 2009

Figure 3.5 above shows another flood drainage channel running from Derreen Turlough and discharging into Lough Fingall. This channel was privately constructed in parallel with the Kiltiernan emergency flood relief scheme in 1995.

3.2 ASSESSMENT OF CHANNEL GEOMETRY

The longitudinal sections on Drawing Nos. 4721/KB/05 and 4721/KB/06 show that the depth of the main channel varies significantly throughout its length. The channel embankments are formed from excavated material, the bed shows evidence of significant rock excavation in places, particularly along the downstream sections from Tullaghnafrankagh Lough. Large flat flood plains are also predominant physical features of this channel.

The bed profile of the channel ranges from a height of 22.38mOD at the upstream section, to 17.70mOD at the downstream section. The overall length of the channel is 2,580m which gives an overall gradient of 1 in 550 approximately. Table 3.1 below gives an indication of the “flow equivalent” for different sizes of open channels at this particular gradient of 1 in 550 :

Shape of channel	1.00m deep x 0.50m wide Side slopes 3/2	1.25m deep x 0.75m wide Side slopes 3/2	1.50m deep x 1.00m wide Side slopes 3/2
Gradient	1 : 550	1 : 550	1 : 550
Flow ² (l/s)	1,585	3,150	5,200

Table 3.1 : “Flow equivalent” for different channel sizes at a gradient of 1 in 550

Taking account of the “flow equivalent” capacities outlined in Table 3.1, the overall gradient of the existing Kiltiernan channel is considered good. However, the actual vertical alignment varies significantly and some sections are particularly flat with backfalls in places. This leads to significant flow restrictions in parts of the existing channel resulting in stagnating waters and associated dense weedy growth which further inhibits flows.

² Flow calculations based on an estimated friction coefficient K of 30

All flow restrictions are shown on Drawings Nos. 4721/KB/05 and 4721/KB/06. Gradients less than 1 in 2,000 are shown in red. Flow restrictions are listed below :

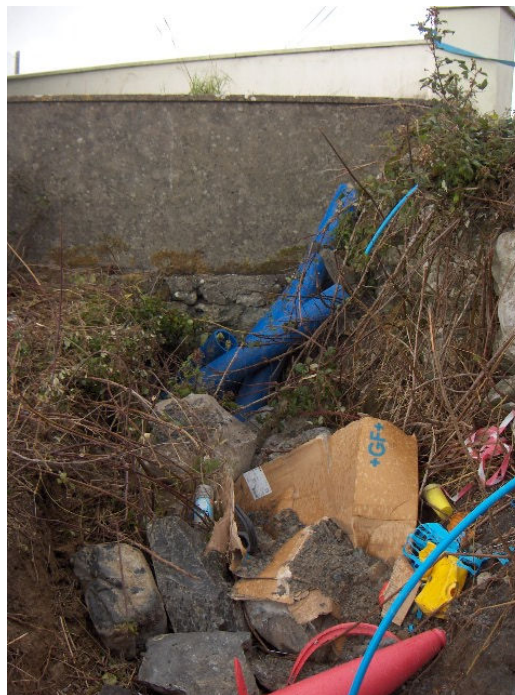
- i. Chainage 0 to 706m – upstream from Keamsellagh flood plain
- ii. Chainage 925 to 1,008m – section located upstream from the control point & piped section leading to Tullaghnafrankagh Lough
- iii. Chainage 1,922 to 2,219m – mixture of open ditches and piped / culverted sections characterised by an overall low gradient and localised backfalls
- iv. Chainage 2,409 to 2,444m – localised backfall along open ditch

3.3 ASSESSMENT OF BRIDGES / CULVERTS / PIPED SECTIONS

Bridges and piped / culverted sections are shown on Drawings No. 4721/KB/05 and 4721/KB/06.

3.3.1 Underground section through Kiltiernan School

At the time of the site visits in August 2010, construction debris was identified at the upstream end of the culverted section at Kiltiernan school and the culvert was partially blocked and inaccessible. According to OPW records, this section through the school was piped using 600mm diameter concrete pipes. The maximum flow capacity under gravity conditions is assessed to be 185 l/s which is considered low in comparison with most of the open sections of the channel which have capacities well in excess of 1,000 l/s.



*Photo No3 – Looking downstream at start of culverted section through
Kiltiernan School (Chainage 361m)*

Refer to Drawing No. 4721/KB/02 for the exact location

3.3.2 Two agricultural bridges at chainages 540 and 552m

Downstream from Kiltiernan school, the channel is piped at two bridges by means of a single 600mm diameter concrete pipe. Under gravity conditions, the 600mm pipe will convey a maximum of 200 to 250 l/s which is considered low in comparison with most of the open sections of the channel.

3.3.3 Road crossing at chainage 706m

The existing 600mm steel pipe crossing the road at chainage 706m (at Kiltiernan West) is capable of conveying a maximum of 225 l/s under gravity conditions which again is considered low in comparison with most of the open sections of the channel.



*Photo No9 – Local Road crossing – Looking upstream at end of piped section
Refer to Drawing No. 4721/KB/02 for the exact location (Chainage 706.27m)*

3.3.4 Piped section between chainage 1,008 and 1,454m

The existing 600mm concrete pipe discharging to Tullaghnafrankagh Lough is capable of conveying a maximum of 175 to 220 l/s under gravity conditions which is considered low in comparison with most of the open sections of the channel.

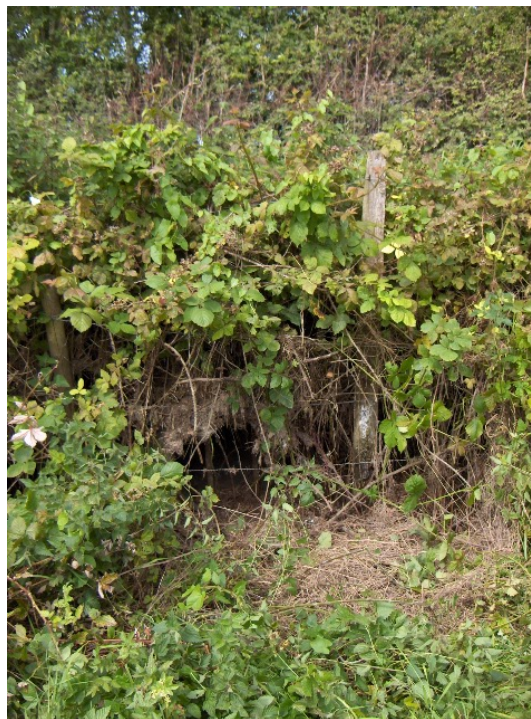


Photo No15 – Looking upstream at end of piped section

Refer to Drawing No. 4721/KB/02 for the exact location (Chainage 1,453.64m)

3.3.5 Piped section between chainage 1,922 and 1,980m

The existing twin 600mm diameter concrete pipe at the outlet of Tullaghnafrankagh Lough is capable of conveying a maximum of 150 l/s under gravity conditions which is considered low in comparison with most of the open sections of the channel. In addition, the first part of this section shows a backfall (negative gradient of -1/900) and overall, the gradient is low at 1 in 3,000 approximately.



*Photo No16 – Looking downstream at start of piped section
Refer to Drawing No. 4721/KB/02 for the exact location*

3.3.6 Underground section between chainage 2,123 and 2,318m

There is an overall backfall over this section (negative gradient 1 in -355 overall) and the channels needs surcharging to convey the flows downstream. In addition, the culvert was constructed using concrete masonry blocks and has become unstable over the years following significant structural movement. Some sections may be close to collapsing which could cause serious flow restrictions.

3.4 SUMMARY AND FLOW TRANSFER CAPACITY ISSUES

The Kiltiernan channel can be characterised as follows :

3.4.1 Localised low gradients at Kiltiernan School and downstream from Tullaghnafrankagh Lough

A natural channel with flat gradients resulting in significant weed growth particularly along the upstream section adjacent to Kiltiernan school and immediately downstream from Tullaghnafrancagh Lough.



*Photo No5 – Looking upstream towards
Kiltiernan School*

*Refer to Drawing No. 4721/KB/02 for the
exact location*



*Photo No17 – Looking downstream –
chainage 1,980.50 metres*

*Refer to Drawing No. 4721/KB/02 for the
exact location*

3.4.2 Overgrown channel banks

Overgrown channel banks where natural vegetation, such as trees and bushes impact on the conveyance capacity of the channel.

3.4.3 Flow restrictions through all underground sections

Low flow capacity through all piped / culverted sections, particularly :

1. Section piped with 2 No. 600mm diameter concrete pipes under the local road to Carraghadoo Village. Overall gradient of approximately 1 in 3000 which gives an overall maximum flow capacity of only 150 l/s
2. Culverted section from chainage 2,123m to 2,318m at Carraghadoo townland. There is an overall backfall over this section (negative gradient of 1 in -355 overall) and the open channel upstream needs to be surcharged to convey the flows downstream.

3.4.4 Structural condition issues – downstream end of the channel

Structural issues in relation to the culverted section from chainage 2,219 to 2,318m at Carraghadoo. The culvert was constructed using masonry blocks and has become unstable over the years following significant structural movement. Further investigation is required to assess the structural condition of the culvert as some sections could be close to collapsing which could cause serious flow restrictions.

4. ASSESSMENT OF THE EXISTING BALLINDERREEN CHANNEL

The Kiltiernan system discharges surface water to Lough Fingall which is surrounded by large flood plains extending up to the townlands of Muggaunagh and Carton located adjacent to the village of Ballinderreen. The Ballinderreen channel is located downstream from the Lough Fingall and surrounding flood plains system.

4.1 CHANNEL ALIGNMENT DESCRIPTION

The horizontal alignment of the channel is shown on Drawing No. 4721/KB/03 attached as Appendix A. The vertical alignment is shown on Drawings Nos. 4721/KB/07 to 4721/KB/10.

At the upstream end, the Ballinderreen channel starts at the main Kilcolgan to Kinvarra Road (N67) by means of twin 600mm diameter pipes crossing under the road. When flood water levels in the upstream flood plains surrounding Lough Fingall rise above 14.10mOD (invert level of twin pipes), the surface water starts overflowing into the Ballinderreen drainage system. This overflow level of 14.10mOD is approximately 1.5 metres below the finished floor levels of the newly built houses located opposite the Ballinderreen Sports Ground.

Immediately downstream from the N67 road crossing, the Ballinderreen channel takes the form of an open channel varying in width from 2.2m to 3.6m and in depth from 1.0m to 1.70m in width. The open channel runs through agricultural fields up to Turlough Caol.

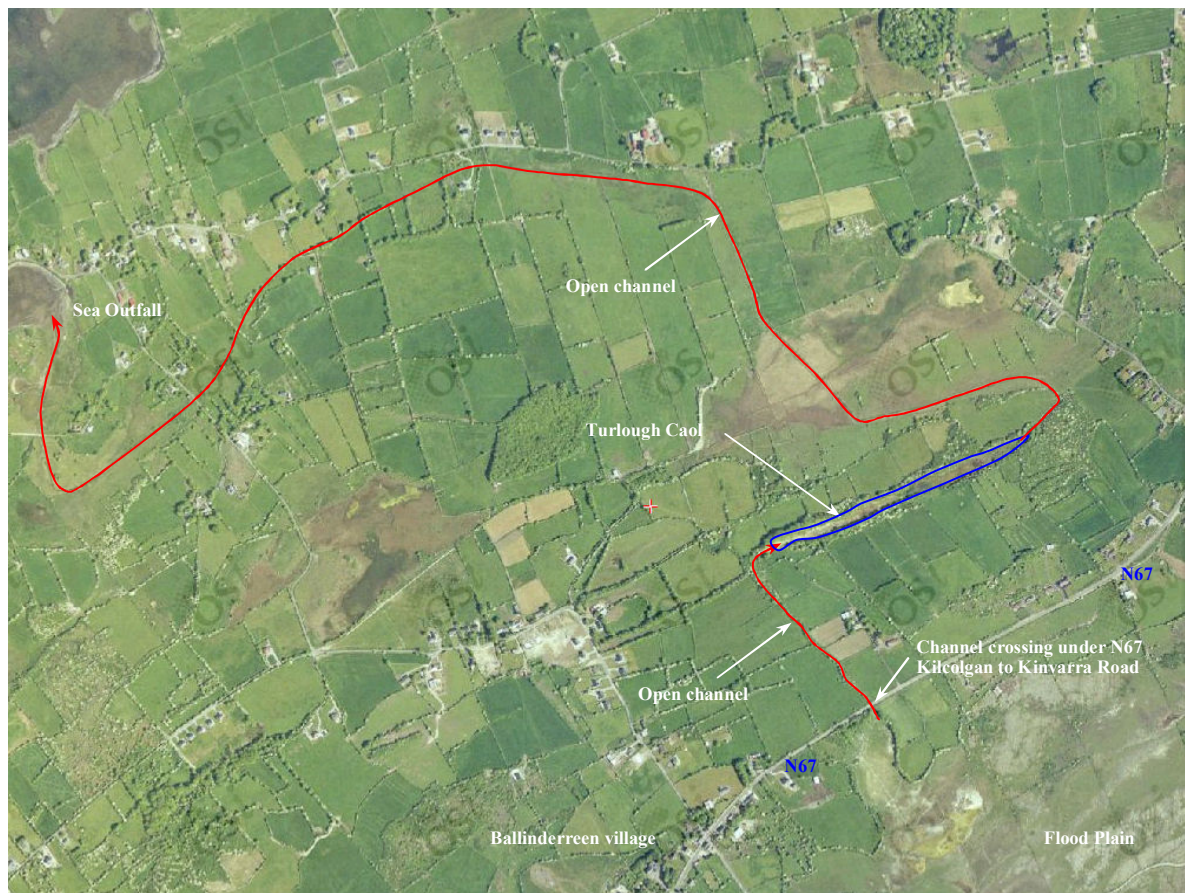


Figure 4.1 : Aerial photo – Ballinderreen Channel

The Ballinderreen channel continues downstream from Turlough Caol to the sea outfall of Brandy Harbour at chainage 4,618m. The open channel varies significantly in width from 1.50m to 4.20m and in depth from 0.35m to 2.0m.

There are 27 bridges mostly for agricultural field access or private dwelling access located along the route of the channel as indicated on Drawings Nos. 4721/KB/07 to 4721/KB/10. The bridge crossings consist mostly of 1.5m wide by 1.0 m deep precast concrete culverts. Reference is made to Section 4.3 for more details and variations on the size of the culverts.

4.2 ASSESSMENT OF CHANNEL GEOMETRY

From examination of the longitudinal sections on Drawings Nos. 4721/KB/07 to 4721/KB/10, it can be seen that the depth of the main channel varies significantly throughout its course. The channel embankments are formed from excavated material and the bed shows significant rock cuts at the following locations :

- Outlet of Turlough Caol to Bridge B24, chainage 1,153 to 1,225m :
 - Chainage 1,153m : negative gradient -1/1,312 over 13m
 - Chainage 1,188m : negative gradient -1/47 over 7m
 - Chainage 1,214m : negative gradient -1/5,485 over 11m
 - Chainage 1,225m : negative gradient -1/2,730 over 5.5m
- Chainage 2,061 to 2,390m, between bridge at B16 and bridge at B19 : solid limestone was encountered while constructing the channel and a number of backfalls have been identified :
 - Chainage 2,061m : negative gradient -1/1,063 over 12m
 - Chainage 2,115m : negative gradient -1/80 over 47m
 - Chainage 2,201m : negative gradient -1/339 over 51.5m
 - Chainage 2,307m : negative gradient -1/1,849 over 41m
- Chainage 3,470 to 3,594m, between bridge at B6 and bridge at B7 : backfall located at chainage 3,552m & negative gradient -1/108 over 10m

Large flat flood plains are also predominant physical features of this channel. Between chainage 1,880 and 3,308m, the variation in invert level is only 1.0m which equates to an overall gradient of 1 in 1,450 approximately, which is considered low.

The bed profile of the channel ranges from a height of 14.10m O.D. at the upstream section (N67 crossing), to 0.56m O.D. at the downstream section (Brandy Harbour). The Highest Astronomical Tide level is 2.23m OD Malin which means that the last 600 metres of the channel are affected by the high tide. The overall length from the head of the channel up to the point where it becomes tidal is 3,973m which gives an overall gradient of 1 in 335

approximately. Table 4.1 gives an indication of the “flow equivalent” for different sizes of open channels using this particular gradient of 1 in 335 :

Shape of channel	1.00m deep x 0.50m wide Side slopes 3/2	1.25m deep x 0.75m wide Side slopes 3/2	1.50m deep x 1.00m wide Side slopes 3/2
Gradient	1 : 335	1 : 335	1 : 335
Flow ³ (l/s)	1,488	2,882	4,883

Table 4.1 : “Flow equivalent” for different channel sizes at a gradient of 1 in 335

The overall gradient of the existing Ballinderreen channel is considered good. However, the actual vertical alignment varies significantly and some sections are particularly flat with many backfalls in places. This leads to significant flow restrictions in parts of the existing channel. It also causes waters to stagnate which encourages dense weed growth which in turn further restricts flows during flood events.

All flow restrictions are shown on Drawings Nos. 4721/KB/07 to 4721/KB/10 and are summarised below. Gradients below 1 in 2,000 are shown red.

- **Chainage 99 to 229m, immediately downstream from the N67 road crossing**
- **Chainage 1,153 to 1,225m, outlet of Turlough Caol to Bridge at B24**
- **Chainage 1,911 to 1,987m, between Bridge at B19 and Bridge at B20**
- **Chainage 2,061 to 2,390m, between Bridge at B16 and Bridge at B19**
- **Chainage 2,421 to 3,308m, between Bridge at B9 and Bridge at B16**

³ Flow calculations based on an estimated friction coefficient K of 22.5

4.3 ASSESSMENT OF BRIDGES / CULVERTS / PIPED SECTIONS

Bridges and culverted sections are shown on Drawings Nos. 4721/KB/07 to 4721/KB/10.

The following assessment was carried out :

4.3.1 Bridges at B1 & B2 – downstream end of the channel

The Bridges at B1 and B2 are located at the downstream end of the channel where flows are affected by the tides. The two bridges are made from precast concrete floor slabs and are used to access agricultural lands. No flow restrictions were identified at this location.



*Photo No37 – Looking downstream towards sea outfall
Refer to Drawing No. 4721/KB/03 for the exact location*

4.3.2 Old masonry arch bridge at B3

The Bridge at B3 is an old masonry arch bridge located on the local access road to Killeenaran village. It is 2.5 metres wide by 1.5 metres high. The flow capacity of this bridge was deemed to be satisfactory. The bridge was rehabilitated and strengthened structurally in September 2010 under the Galway County Council Bridge Repair Programme 2010.



*Photo No33 – Looking upstream to Bridge No3
August 2010 prior to Rehabilitation Works
Refer to Drawing No. 4721/KB/03 for the exact
location*



*Photo No33 bis – Looking upstream to Bridge No3
September 2010 post Rehabilitation Works
Refer to Drawing No. 4721/KB/03 for the exact
location*

4.3.3 Precast concrete box culvert bridges from B4 to B8

The Bridges from B4 to B8 are used for agricultural land access. They consist of precast concrete box culverts 1.5 metres wide by 1.0 metre high. No flow restrictions were identified for these particular culverts. The structural condition of the culverts is good.



*Photo No30 – Looking upstream to B4
Refer to Drawing No. 4721/KB/02 for the
exact location*



*Photo No31 – Looking upstream to B4
Refer to Drawing No. 4721/KB/02 for the
exact location*

4.3.4 Precast concrete box culvert bridges at B9 and B11

The Bridges at B9 and B11 are constructed from precast concrete floor slabs. No flow restrictions were identified at these locations.

4.3.5 Precast concrete box culvert bridges at B10 and B12

The Bridges at B10 and B12 are used for agricultural land access. They again consist of precast concrete box culverts 1.5 metres wide by 1.0 metre high. No flow restrictions were identified at these locations.



Photo No30 – B4

Refer to Drawing No. 4721/KB/02 for the exact location



Photo No31

Looking downstream from B12

*Refer to Drawing No. 4721/KB/02
for the exact location*

4.3.6 Wooden footbridge at B13

The Bridge at B13 is a wooden footbridge. No flow restriction was identified at this location.

4.3.7 Precast concrete box culvert bridge at B14

The Bridge at B14 is used to access a private dwelling. It is a precast concrete box culvert 1.5 metres wide by 1.0 metre high. No flow restriction was identified at this location.

4.3.8 Old stone bridge at B15

The Bridge at B15 is used to access agricultural lands. This is an old stone bridge in structurally poor condition, measuring 0.7m wide by 1.1m high which is considered to be undersized. Flow capacity through this bridge / culvert is estimated to be approximately 330 l/s which is low in comparison with most of the open sections and culverted sections of the channel showing capacities well in excess of 1,000 l/s



*Photo No20 – Looking downstream to B15
Refer to Drawing No. 4721/KB/02 for the
exact location*



*Photo No21 – Looking upstream from B15
Refer to Drawing No. 4721/KB/02 for the
exact location*

4.3.9 Precast concrete box culvert bridges from B16 to B20

The Bridges from B16 to B20 are used for agricultural lands access. They consist of precast concrete box culverts 1.5 metres wide by 1.0 metre high. No flow restrictions were identified for these particular culverts. The structural condition of the culverts is good.



*Photo No17 – Looking upstream to B16
Refer to Drawing No. 4721/KB/02 for the
exact location*



*Photo No14 – Looking upstream to B19
Refer to Drawing No. 4721/KB/02 for the
exact location*

4.3.10 Precast concrete floor slab bridge at B21

The Bridge at B21 is constructed from precast concrete floor slabs and no flow restrictions were identified at this location.

4.3.11 Precast concrete box culvert bridges from B22 to B24

The Bridges from B22 to B24 are used for agricultural land access. They were constructed from precast concrete box culverts 1.5 metres wide by 1.0 metre high. No flow restrictions were identified at these locations. The structural condition of the culverts is good.



Photo No09 – Looking upstream to Bridge No.23

Refer to Drawing No. 4721/KB/03 for the exact location

4.3.12 Concrete culvert bridges at B25 and B26

The Bridges at B25 and B26 are used for agricultural land access. They consist of concrete culverts 1.75m wide by 1.0m high made from masonry blocks. No flow restrictions were identified at these locations. The structural condition of the culverts is good.



Photo No04 – Looking downstream to Bridge No.26

Refer to Drawing No. 4721/KB/03 for the exact location

4.3.13 N67 Kilcolgan to Kinvarra Road crossing – B27

On the N67 Kilcolgan to Kinvarra Road crossing at B27, twin 600mm diameter steel pipes were placed under the N67 roadway. The pipes can be inspected via an existing access chamber located on the upstream end of the crossing. The structural condition is acceptable and the flow capacity under gravity conditions was found to be approximately 1,050 l/s which is good in comparison with the overall achievable flow transfer capacity of the channel.



*Photo No01 – Inspection chamber B27
Refer to Drawing No. 4721/KB/02 for the
exact location*



*Photo No02 – Looking downstream to B27
Refer to Drawing No. 4721/KB/02 for the exact
location*

4.4 SUMMARY AND FLOW TRANSFER CAPACITY ISSUES

The condition of the Ballinderreen Channel can be characterised as follows :

4.4.1 Localised low gradients

A natural channel with flat gradients resulting in significant weedy growth particularly within the sections identified in Section 4.2 of this Report. This is particularly the case in the following locations :

1. Chainage 99 to 229m – immediately downstream from the N67 road crossing
2. Chainage 1,153 to 1,225m – Outlet of Turlough Caol to Bridge B24
3. Chainage 1,911 to 1,987m – i.e. between Bridge B19 and Bridge B20
4. Chainage 2,061 to 2,390m – i.e. between Bridge B16 and Bridge B19
5. Chainage 2,421 to 3,308m – i.e. between Bridge B9 and Bridge B16



Photo No05 – Looking upstream from B26
Overgrown channel banks
Refer to Drawing No. 4721/KB/02 for the exact location



Photo No16 – Looking downstream from B18
Weedy growth & stagnating waters
Refer to Drawing No. 4721/KB/02 for the exact location

4.4.2 Overgrown channel banks

Overgrown channel banks where natural vegetation, such as trees and bushes that impact on the conveyance capacity of the channel.

4.4.3 Structural condition issues – stone bridge at B15

Structural issues and flow capacity issues in relation to the stone culvert at B15 which requires reconstruction.

5. **PROPOSED CHANNEL MAINTENANCE / RESTORATION WORKS**

The following Section details the extent of the works to be carried out in order to maintain the existing channels and restore natural flow conditions.

5.1 **ECOLOGICAL & ENVIRONMENTAL CONSIDERATIONS**

The South Galway Flood Study Report dated April 1998 stated in Section 4 that the extent to which any flood levels could be alleviated is fundamentally and primarily determined by the flora and fauna encountered within any given flood plain. There are a number of flood plains in the study area including :

- **Kiltiernan Flood Plain**
- **Keamsellagh Flood Plain**
- **Tullaghnafrankagh Flood Plain**
- **Lough Fingall Flood Plain**
- **Ballinderreen Flood Plain**
- **Turlough Caol Flood Plain**

It should be noted that some invert levels referred to as “control points” in this report will not be altered under the Works proposed in this Section. The “control points” are located immediately downstream from each of the above flood plains and will therefore remain unaltered in order to avoid any ecological impact.

The “control points” are as follows :

- **Kiltiernan Area (refer to Drawings 4721/KB/05 and 4721/KB/06):**
 - Chainage 99m : channel IL to remain at 22.53m OD Malin
 - Chainage 1,008m : channel IL to remain at 21.53m OD Malin
 - Chainage 1,922m : channel IL to remain at 19.44m OD Malin
- **Ballinderreen Area :**
 - Chainage 65m : channel IL to remain at 14.11m OD Malin
 - Chainage 1,166m : channel IL to remain at 10.24m OD Malin

It should also be noted that some of the works proposed in this report may require further assessment in terms of their environmental impacts as a number of Designated Areas are located within the Kiltiernan / Ballinderreen channel catchment (Special Areas of Conservation and Special Protection Areas). Some Special Areas of Conservation are also presently proposed as Natural Heritage Areas, namely :

- **Lough Fingall and surrounding flood plains**
- **Carraghadoo Area**
- **Derreen Turlough**
- **Tullaghnafrankagh Lough**
- **Keamsellagh flood plain**
- **Brandy Harbour**

Drawing 4721/KB/12 shows the location of Designated Areas adjacent to the Kiltiernan and Ballinderreen Channels.

5.2 KILTIERNAN CHANNEL – PROPOSED WORKS

5.2.1 Cleaning Works

Cleaning is necessary over the entire length of the Kiltiernan Channel. In addition to the regrading / upsizing works, it is recommended that cleaning be carried out to maintain the capacity of the channel.

5.2.2 Regrading Works / Open Channel Sections

It is proposed to regrade some sections of the channel in order to avoid low gradients and backfalls / negative gradients which create significant restrictions in flows and increase the frequency and cost of maintenance works.

The following open channel sections require regrading :

5.2.2.1 Chainage 99m to 361m (Node E5)

Regrade a 262m long section to a gradient of 1 in 2,900 as shown on drawing 4721/KB/05. This is the maximum gradient that can be achieved due to the existing culverted section downstream at E5. It is recommended that the regraded channel be 1.0m wide at the base and have side slopes of 3/2. The depth of the new channel would vary between 585mm and 1100mm which provides a minimum flow capacity of 510 l/s approx.

5.2.2.2 Chainage 446m (Node MH) to 707m (Node E)

Regrade a 261m long section to a gradient of 1 in 1,280 as shown on drawing 4721/KB/05. This is the maximum gradient that can be achieved due to the existing piped section downstream at E. It is recommended that the regraded channel be 1.0m wide at the base and have side slopes of 3/2. The depth of the channel would vary between 480mm and 1435mm which provides a minimum flow capacity of 520 l/s approx.

5.2.2.3 Chainage 1,980.5m (Node H3) to 2,123m (Node H2)

Regrade a 142m long section to a gradient of 1 in 800 as shown on drawing 4721/KB/06. This is the maximum gradient that can be achieved due to the existing culverted section downstream at H2. It is recommended that the regraded channel be 1.8m wide at the base and have side slopes of 3/2. The depth of the channel would vary between 480mm and 1,290mm which provides a minimum flow capacity of 1,050 l/s approx.

5.2.2.4 Chainage 2,318m (Node H1) to 2,478m

Regrade a 159m long section to a gradient of 1 in 800 as shown on drawing 4721/KB/05. It is recommended that the regraded channel be 1.0m wide at the base and have side slopes of 3/2. The depth of the channel would vary between 1,780mm and 2,780mm which provides a minimum flow capacity in excess of 2,000 l/s

5.2.3 Underground Sections Maintenance / Relaying Works

It is recommended that the above Regrading Works be carried out in conjunction with some Relaying / Upsizing Works of the culverted underground sections in order for the scheme to be consistent and effective. The recommended Relaying / Upsizing Works are as follows :

5.2.3.1 Chainage 361m (Node E5) to 446m (Node MH)

Construct a 900mm diameter concrete pipe to replace the existing pipe through Kiltiernan School grounds at a gradient of 1 in 450, overall length 85m. The flow capacity of the upsized section would be in excess of 750 l/s which is consistent with the regrading works proposed on the upstream and downstream sections.

5.2.3.2 Chainages 540m and 552m

Construct a 900mm diameter pipe to replace the existing 600mm pipe for both agricultural bridges as indicated on Drawing 4721/KB/05.

5.2.3.3 Chainage 1,008m (Node H7) to 1,454m (Node H6)

Construct a 900mm diameter concrete pipe to replace the existing pipe between Keamsellagh Flood Plain and Tullaghnafrankagh Lough at a gradient of 1 in 365, overall length 446m. The flow capacity of the upsized section would be in excess of 750 l/s approximately, which is consistent with the regrading works proposed on the upstream sections.

5.2.3.4 Chainage 1,922m (Node H4) to 1,980.5m (Node H3)

Upsize the existing twin 600mm diameter pipes crossing under the local access road to Carraghadoo with a single 1050mm diameter concrete pipe. It is recommended that the new pipe be laid at a gradient of 1 in 800, overall length 58.5m. The flow capacity of the new structure would be 810 l/s approx which is consistent with the regrading works proposed on the upstream and downstream sections.

The local road was recently raised to a level of 20.85mO.D. which is 400mm above the crown of the proposed 1050mm concrete pipe.

5.2.3.5 Chainage 2,123m (Node H2) to 2,318m (Node H1)

Upsize the existing underground section between chainage 2,123 and 2,318m using a 1050mm diameter concrete pipe. It is recommended that the new structure be laid at a gradient of 1 in 800, overall length 195.5m. The flow capacity of the new structure would be 810 l/s approx which is consistent with the regrading works proposed on the upstream and downstream sections.

The depth to the crown of the proposed 1050mm pipe over the first 50 metres of this upsized section will not be sufficient and it is recommended that soil be imported to raise the ground levels of the field locally by 0.75m maximum. Alternatively, an ellipsoidal pipe can be used instead of a 1050mm pipe to avoid the necessity to raised ground levels.

5.2.4 Impact of the Future M18 Motorway on the Kiltiernan Channel

The layout of the future M18 in the Kiltiernan area is shown on Drawing 4721/KB/13. The proposed M18 motorway scheme includes a major junction in the Kiltiernan area, located at the upstream end of the Kiltiernan channel. As shown on the drawing, the existing Kiltiernan channel will cross the future motorway at three separate locations. The following are the recommendations for the Kiltiernan channel drainage at these locations :

1. Crossing under the main proposed M18 motorway : it is recommended that the design of the proposed M18 motorway include for piping the Kiltiernan channel using a 900mm dia. pipe 50 metres long approx to include pre cast splayed wing walls at the upstream and downstream ends
2. Crossing under a proposed access road : it is recommended that the design of the proposed access road include for piping the Kiltiernan channel using a 900mm dia. pipe 50 metres long approx to include pre cast splayed wing walls at the upstream and downstream ends
3. Crossing under a proposed roundabout : it is recommended that the design of the proposed roundabout include for piping the Kiltiernan channel using a 900mm dia. pipe 80 metres long approx to include pre cast splayed wing walls at the upstream and downstream ends

The proposed M18 motorway will run through lands presently waterlogged and prone to winter flooding in the Kiltiernan area. The above recommendations will allow flood waters to be transferred freely from the southern side to the northern side of the proposed M18 motorway which is presently the natural flow pattern in the area.

A meeting was held with the National Road Authority (NRA) to discuss the above recommendations and to ascertain the NRA proposals in respect of drainage at this location. The NRA are generally providing 1200mm diameter pipes underneath the proposed network of roads at this location. An attenuation area is also proposed. In consideration of providing continuity with the NRA proposals, the option of upsizing the

diameter of the culverted section of the Kiltiernan scheme from 900mm to 1200mm was reviewed. However, in examining this option, the following issues arose which rendered this proposed upsizing option unfeasible :

- At Kiltiernan School, the cover to invert level available at the culverted section varies from 1.0m (upstream point) to 1.48m (downstream point). This is insufficient for a 1200mm diameter pipe and the car park would have to be raised significantly, or the invert of the culvert dropped by 0.5m.
- The local road at Carraghadoo located at chainage 1942m was raised recently and the cover to invert level available is currently approximately 1.45m. This is insufficient for a 1200mm diameter pipe and the road would have to be raised by a further 0.3 to 0.4m, or the invert of the culvert dropped.
- Further downstream at chainage 2123m, the cover to invert level available at the upstream end of the culverted section is only 0.66m. Upsizing to 1200mm pipe at this location would mean raising local ground levels significantly or dropping the invert of the culvert which would require excavating into solid limestone.

In summary, the proposed improvements to the Kiltiernan channel based on 900mm diameter pipes and 1050mm diameter pipes at respective locations remains the recommended option.

5.2.5 Derreen Turlough to Lough Fingall Flood Alleviation Route

Section 3.1 of this Report described an open channel that was built by the local residents as part of emergency flood relief works from Derreen Turlough to Lough Fingall.



Figure 5.1 : Aerial photo – Existing Derreen Turlough drainage channel

JOD carried out surveying work in August 2010 in the Kiltiernan Area and it was determined that a flood alleviation route could be constructed to hydraulically link the Keamsellagh Flood Plain and Lough Fingall during flood conditions. This would alleviate the amount of flood water entering the Tullaghnafrankagh Lough system in flood conditions only. Drawing No. 4721/KB/11 shows the details of the alleviation route and the option of constructing a short underground section (piped or culverted) to shortcut or by-pass Tullaghnafrankagh Lough under heavy flooding conditions.

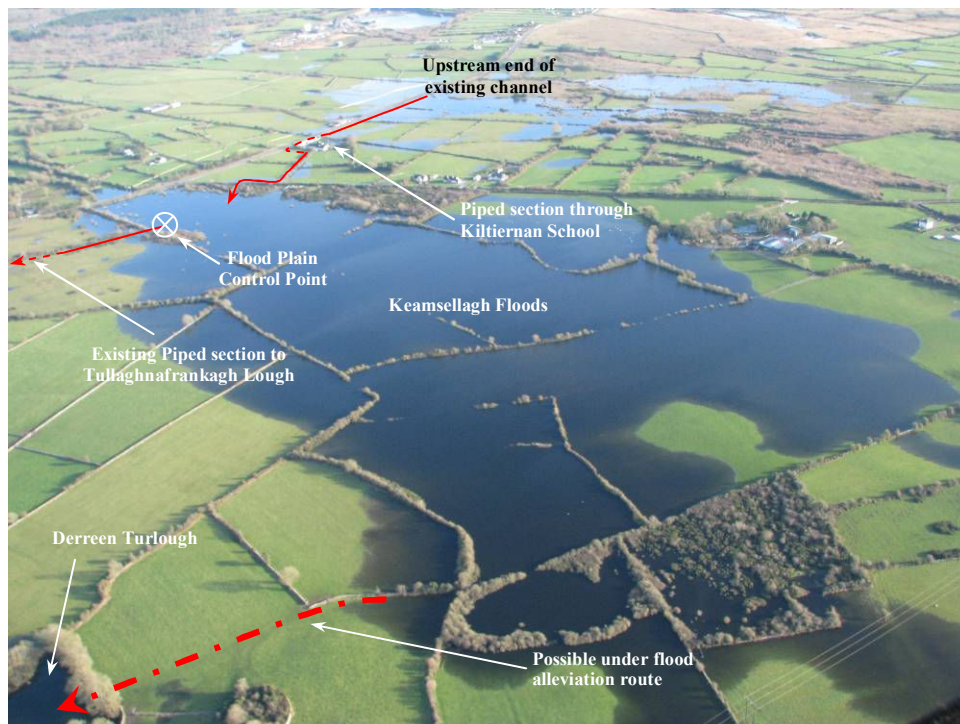


Figure 5.2 : Aerial photo – Keamsellagh Floods

This possible alleviation route was not however further investigated as it creates ecological issues through the alteration of hydrological dynamics in the area. The National Parks & Wildlife Service have expressed concerns over the above alleviation route and the possibility of significant environmental damage to Lough Fingall which is registered as a Special Area of Conservation. Any proposal to alleviate flooding through Derreen Turlough would require a full Environmental Impact Assessment.

5.3 BALLINDERREEN CHANNEL – PROPOSED WORKS

5.3.1 Cleaning Works

Cleaning is necessary over the entire length of the Ballinderreen Channel. In addition to the improvement works detailed below, it is recommended that cleaning be carried out to maintain the capacity of the channel.

5.3.2 Regrading Works / Open Channel Sections

It is proposed to regrade some sections of the channel in order to avoid low gradients and backfalls leading to stagnating waters.

The following open channel sections require regrading :

5.3.2.1 Chainage 92m (Node B27) to 162m

Regrade a 70m long section to a gradient of 1 in 685 as shown on Drawing 4721/KB/07. It is recommended that the regraded channel be 0.75m wide at the base and have side slopes of 3/2. The depth of the channel would vary from 0.67m to 1.30m which provides a minimum flow capacity of 1,150 l/s approx.

5.3.2.2 Chainage 190m to 256m

Regrade a 66m long section to a gradient of 1 in 500 as shown on Drawing 4721/KB/07. It is recommended that the regraded channel be 0.75m wide at the base and have side slopes of 3/2. The depth of the channel would vary from 1.20m to 1.70m which provides a minimum flow capacity in excess of 1,500 l/s.

5.3.2.3 Chainage 340m to 421m

Regrade a 80m long section to a gradient of 1 in 350 as shown on Drawing 4721/KB/07. It is recommended that the regraded channel be 0.75m wide at the base and have side slopes of 3/2. The depth of the channel would vary from 1.25m to 1.40m which provides a minimum flow capacity in excess of 1,500 l/s.

5.3.2.4 Chainage 1,166m to 1,231m

Regrade a 65m long section to a gradient of 1 in 380 as shown on Drawing 4721/KB/08. It is recommended that the regraded channel be 1.25m wide at the base and have side slopes of 3/2. The depth of the channel would vary from 0.44m to 1.35m which provides a minimum flow capacity of 1,000 l/s.

5.3.2.5 Chainage 1,911m to 3,319m

Regrade a 1,408m long section to a gradient of 1 in 1,200 as shown on Drawing 4721/KB/09. It is recommended that the regraded channel be 1.50m wide at the base and have side slopes at 3/2. The depth of the channel would vary from 0.60m to 2.10m which provides a minimum flow capacity of 1,100 l/s.

5.3.2.6 Chainage 4,046.5m to 4,308m

Regrade a 261m long section to a gradient of 1 in 1,280 as shown on Drawing 4721/KB/10. It is recommended that the regraded channel be 1.25m wide at the base and have side slopes of 3/2. The depth of the channel would vary from 0.75m to 1.28m which provides a minimum flow capacity of 1,450 l/s.

5.3.3 Culverts / Bridges Reconstruction Works

It is recommended that the regrading works described above be carried out in conjunction with the following culverts / bridges reconstruction works in order for the scheme to be consistent and to maximise the scheme's effectiveness :

5.3.3.1 Bridge B19

Regrading works are proposed at this location and the culvert would need to be lowered by 175mm.

5.3.3.2 Bridge B18

Regrading works are proposed at this location and the culvert would need to be lowered by 125mm.

5.3.3.3 Bridge B17

Regrading works are proposed at this location and the culvert would need to be lowered by 440mm.

5.3.3.4 Bridge B15

The entire structure would have to be replaced by a precast concrete box culvert 1,750mm wide by 750mm high.

5.3.3.5 Bridge B14

Regrading works are proposed at this location and the culvert would need to be lowered by 225mm.

5.3.3.6 Bridge B12

Regrading works are proposed at this location and the culvert would need to be lowered by 170mm.

6. CONCLUSION & RECOMMENDATIONS / COST ESTIMATE & COST BENEFIT

6.1 SUMMARY

The following is a summary of the works required :

- Regrading Works :
 - Kiltiernan channel : 825 metres
 - Ballinderreen channel : 1,950 metres
- Kiltiernan channel underground sections Works :
 - Building Ø900 CO pipes : 545 metres
 - Building Ø1050 CO pipes: 260 metres
- Works associated with the future M18 – upstream end of the Kiltiernan channel :
 - Building Ø900 CO pipes : 180 metres
- Ballinderreen Bridges / Culverts Works :
 - Lower 5 No. culverts
 - Rebuild the stone bridge at B15 using a precast concrete box culvert 1.75m wide x 0.75m high

In addition to the above works, it is recommended to undertake cleaning works over the entire length of both the Kiltiernan channel and the Ballinderreen channel :

- Cleaning Works – open channels :
 - Kiltiernan channel : 1,200 metres
 - Ballinderreen channel : 3,950 metres

The following table presents the estimate of the costs for carrying out the above Works :

6.2 COST ESTIMATE

The cost estimate is detailed as follows :

Ref.	Description:	Quant	Unit	Rate	Total
1.	Regrading Works - Kiltiernan Channel	825	m	€7.75	€6,393.75
2.	Regrading Works - Ballinderreen Channel	1,950	m	€7.75	€15,112.50
3.	Extra costs over items 1 & 2 for rock breaking		sum		€10,000.00
4.	900mm diameter pipe - Kiltiernan Channel	545	m	€190.00	€103,550.00
5.	1050mm diameter pipe - Kiltiernan Channel	260	m	€200.00	€52,000.00
6.	Lower existing culverts - Ballinderreen Channel	5	nr	€2,000.00	€10,000.00
7.	Replace existing culvert with 1.5m x 1.0m precast concrete box - Ballinderreen Channel	1	nr	€7,000.00	€7,000.00
8.	Cleaning existing open channel - Kiltiernan	1,200	m	€4.00	€4,800.00
9.	Cleaning existing open channel - Ballinderreen	3,950	m	€4.00	€15,800.00
10.	Sub-Total				€224,656.25
11.	Preliminaries at 10%				€22,465.63
12.	Contingency at 15%				€33,698.44
13.	Nett Total				€280,820.31
14.	Add VAT at 13.5%				€37,910.74
15.	TOTAL				€318,731.05

The overall estimated construction cost for carrying out the Works is €318,731 approximately including VAT or €280,820 excluding VAT at 13.5%.

6.3 COST BENEFIT ANALYSIS

A high level cost benefit analysis was carried out and compared with the above cost estimate. The results are detailed in the following table⁴ :

Ref.	Description:	Quant	Unit	Rate	Total
1.	Home flooded	-	nr	€25,000.00	€0.00
2.	Home at risk of flooding*	10	nr	€10,000.00	€100,000.00
3.	Commercial premises flooded	1	nr	€30,000.00	€30,000.00
4.	Agricultural lands flooded	168	hectare	€400.00	€67,096.00
5.	Road closure - Journeys > 30min due to diversion**	-	nr	€20.00	€0.00
6.	Home cut off by flooding***	13	nr	€13,440.00	€174,720.00
7.	TOTAL				€371,816.00
8.	Cost Benefit Ratio				1.17

* Kiltiernan School is taken as being equivalent to the cost of 8 nr. Homes.

** A number of local roads were impassable based on data provided by Galway County Council namely LP4506, LS8594, LS8558 and LP4505. The diversions were not however greater than 30 minutes.

***Local cul de sac to Carraghadoo cut off by the 2009 floods – 13 houses cut off for 12 weeks based on data provided by Galway County Council. This access road was since raised in the summer 2010.

The overall cost incurred by the local community as a result of flooding is estimated to be €371,816 which is approximately 117% of the cost of the proposed improvement works on the Kiltiernan and Ballinderreen channel. Further benefit would be gained from a Health & Safety point of view by preventing flooding of individual wastewater treatment systems such as septic tanks, particularly at Kiltiernan School.

⁴ The rates used for the purpose of assessing the financial impact of flooding is based on the Minor Works Funding Framework

APPENDIX A:

DRAWINGS

APPENDIX B:

PHOTOS

APPENDIX B.1:

KILTIERNAN AREA PHOTOS

Photos - On site visit 23/08/2010 to 27/08/2010

Photo No01



Photo No02



Photo No03



Photo No04



Photo No05



Photo No06



Photo No07



Photo No08



Photos - On site visit 23/08/2010 to 27/08/2010

Photo No09



Photo No10



Photo No11



Photo No12



Photo No13



Photo No14



Photo No15



Photo No16



Photos - On site visit 23/08/2010 to 27/08/2010

Photo No17



Photo No18



Photo No19



Photo No20



Photo No21



Photo No22



Photo No23



Photo No24



APPENDIX B.2:

BALLINDERREEN AREA PHOTOS

Photos - On site visit 23/08/2010 to 27/08/2010

Photo No01



Photo No02



Photo No03



Photo No04



Photo No05



Photo No06



Photo No07



Photo No08



Photos - On site visit 23/08/2010 to 27/08/2010


Photo No09	Photo No10	Photo No11	Photo No12
			

Photo No13


Photos - On site visit 23/08/2010 to 27/08/2010

Photo No14



Photo No15



Photo No16



Photo No17



Photo No18



Photo No19



Photo No20



Photo No21



Photos - On site visit 23/08/2010 to 27/08/2010

Photo No22



Photo No23



Photo No24



Photo No25



Photo No26



Photo No27



Photo No28



Photo No29



Photos - On site visit 23/08/2010 to 27/08/2010

Photo No30



Photo No31



Photo No32



Photo No33



Photo No34



Photo No35



Photo No36



Photo No37

