



KILGALLEN & PARTNERS

CONSULTING ENGINEERS

Stage 1 Flood Risk Assessment

for

**Variation No. 2 of the Athy Town Development Plan
2012-2018**

at

Land in Woodstock South, Athy

**Boortmalt Ltd.
The Maltings
Lower William St.
Athy, Co. Kildare**

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DOCUMENT AMENDMENT HISTORY

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1. **INTRODUCTION**

Kildare County Council has adopted Variation No. 2 to the Athy Town Development Plan 2012 – 2018. The variation rezoned 3.4 hectares of land in Woodstock South, Athy from Zoning Objective R – Retail and Commercial: “To provide for and improve retailing and commercial activities” to Zoning Objective Q – “Enterprise and Employment”.

Kilgallen and Partners Consulting Engineers have been appointed to carry out a Stage 1 Flood Risk Assessment ('FRA') of lands that are the subject of Proposed Variation No. 2 ('the Study Area') in accordance with the *'Planning System and Flood Risk Management – Guidelines for Planning Authorities (2009)'* [the 'FRM Guidelines'] to support its application for the change in land-use classification.

This report presents the findings of this FRA. It has been prepared to support the variation to the Development Plan to rezone the subject lands only and is not to be used for any other purpose.

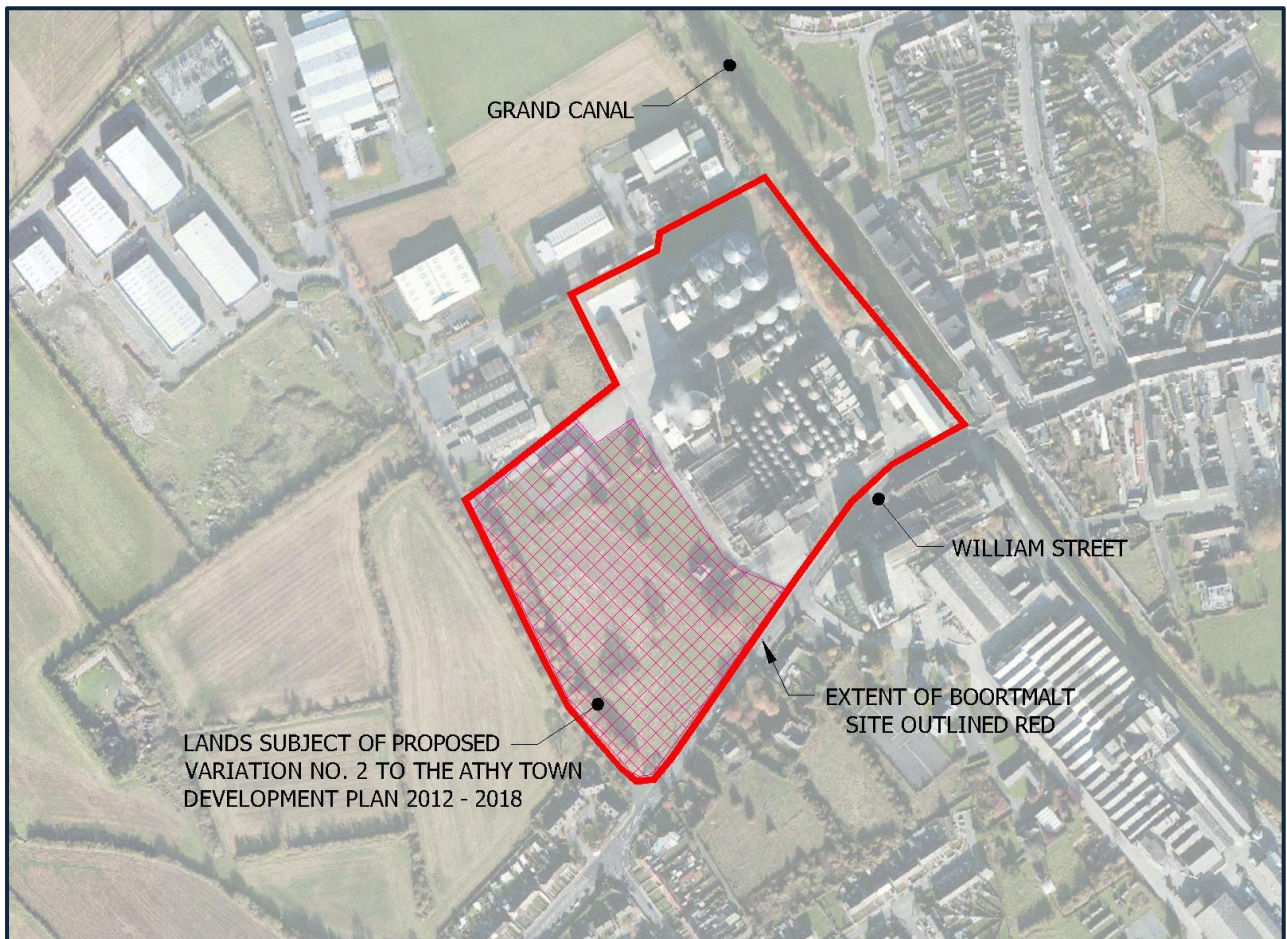


Figure 1.1 – Extent of Boortmalt Site and of Lands Classified for Retail / Commercial Use

2. PROCESS FOR STAGE 1 FLOOD RISK ASSESSMENT

The Stage 1 FRA provides an appraisal and assessment of available flood risk data in order to identify flood risk indicators in the Study Area.

2.1 POTENTIAL SOURCES OF FLOOD RISK

The Study Area is subject to the three potential flood risk mechanisms described below (as an inland site, the Study Area is not subject to coastal flood risk).

- (i) Fluvial: flooding caused by overtopping of Rivers and Streams;
- (ii) Pluvial: flooding caused when the intensity of rainfall events is such that the ground cannot absorb rainfall run-off effectively or urban drainage systems cannot carry the run off generated;
- (iii) Groundwater: flooding caused by a rise in the level of the water table.

2.2 FLOOD RISK INDICATORS

Indicators of flood risk are identified using available data, most of which is historically derived. Typically, this data is not prescriptive in relation to flood return periods and neither predictive nor inclusive of climate change analysis.

Flood risk indicators include:

- (i). Records available on the OPW's National Flood Risk Website
As part of the National Flood Risk Management Policy, the OPW developed the www.floodmaps.ie web based data set, which contains information concerning historical flood data and displays related mapped information and provides tools to search for and display information about selected flood events.
- (ii). PFRA mapping produced under the CFRAM programme
Preliminary Flood Risk Assessment Mapping, produced by the OPW as part of the CFRAM programme, showing Areas of Potential Significant Flood Risk;
- (iii). SFRA for Local Area Plan
The Strategic Flood Risk Assessment carried out to inform the making of the Local Area Plan
- (iv). Geological Survey of Ireland (GSI) mapping
Hydrogeological mapping maintained by the GSI and made available through its website www.gsi.ie.
- (v). Ordnance Survey mapping
Ordnance Survey maps include areas which are marked as being "Liable to Floods". Generally, these areas are only shown identified indicatively and suggest historical flooding, usually recurrent. In addition, the maps indicate areas of wet or hummocky ground, bog, marsh, springs, rises and wells as well as surface water features including rivers, streams, bridges, weirs and dams.

- (vi). Topographical survey information
Available topographic survey information
- (vii). Records of previous floods from other sources
- (viii). Flood Studies, Reports and Flood Relief Schemes carried out in the vicinity of the Study Area.

3. DETAILS OF THE STUDY AREA

The Study Area is located at the western fringe of Athy; Figures 3-1 and 3-2 shows its context in terms of the western side of Athy and the surrounding river system.

The Study Area is approximately rectangular in shape. It is bounded by Lower William Street, the existing Boortmalt Facility, a third party industrial facility and agricultural lands.

The Study Area is in the catchment of the Barrow River, approximately 1km immediately upstream of the confluence of the Barrow and its tributary, the Ballyadams River. At the closest points, the Study Area is located approximately 500m from each river. The lands immediately surrounding the Study Area fall gently towards the Barrow, however, much of the land west of the Study Area actually falls away towards the Ballyadams River.

The Grand Canal runs in a southeast – northwest direction between the Study Area and the Barrow and, at its closest, is located 185m from the Study Area.

There are no significant drainage features within the Study Area.

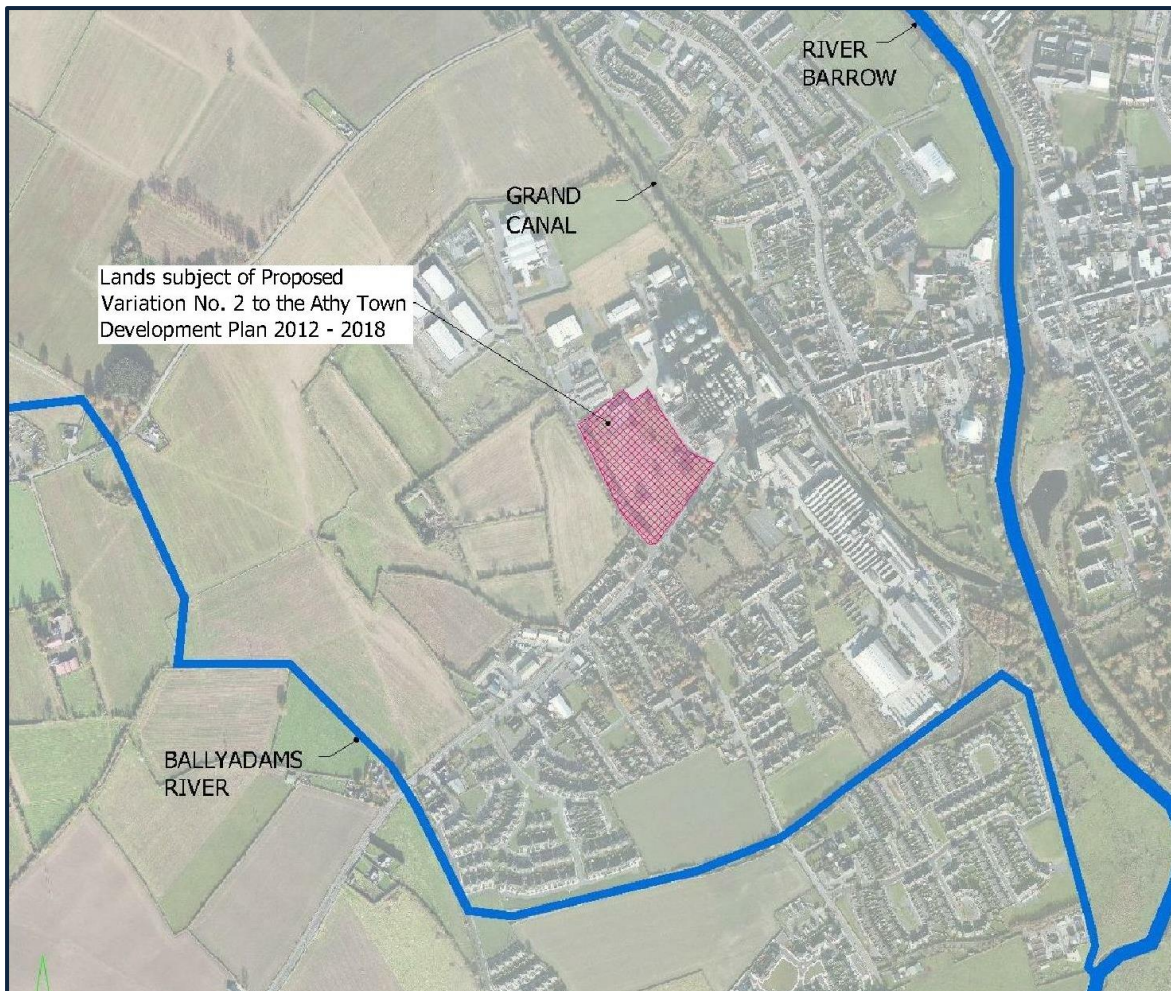


Figure 3-1 Study Area in the Context of Surrounding Rivers

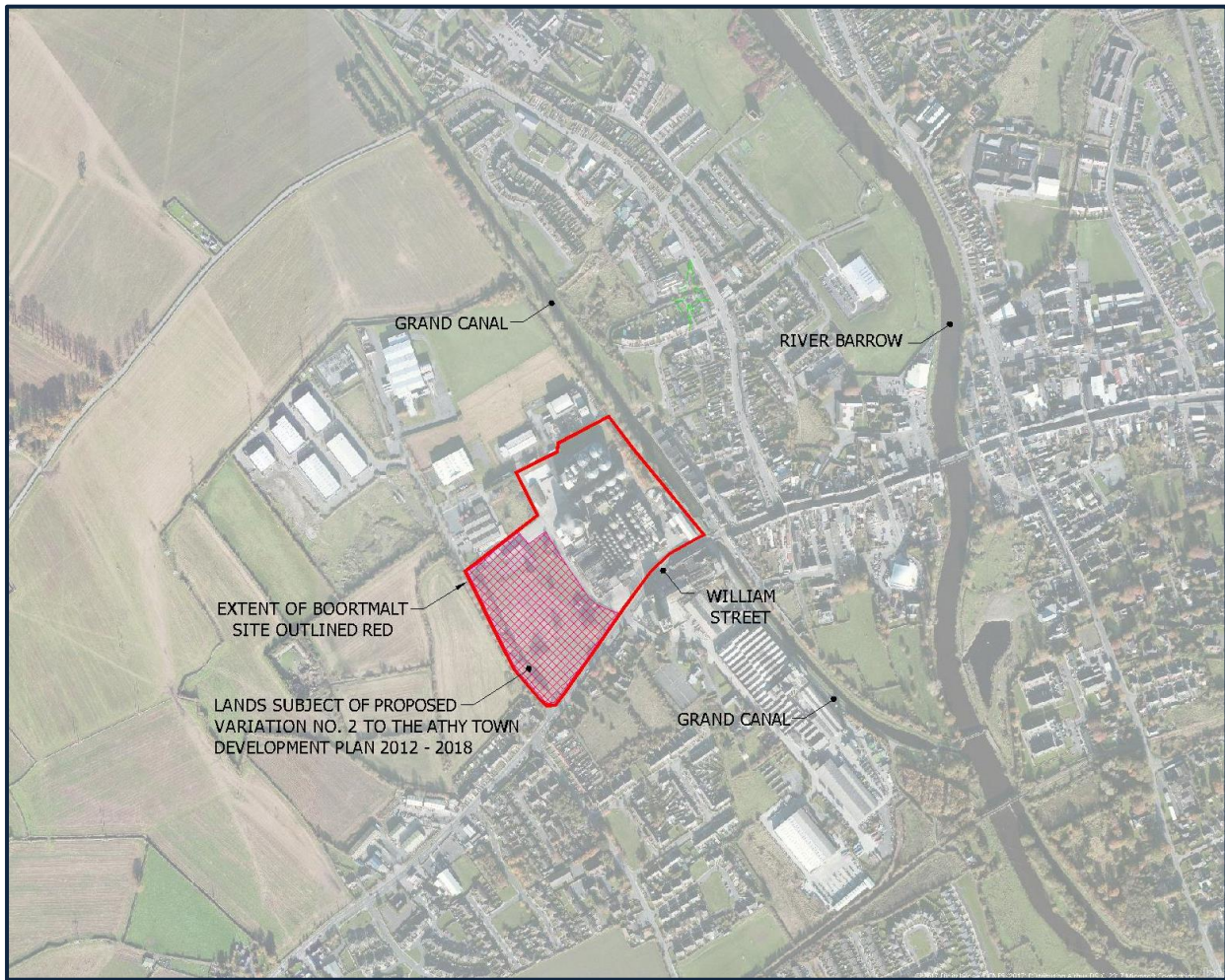


Figure 3-2 Study Area in the Context of Athy

4. **FLUVIAL FLOOD RISK**

4.1 FLOOD RISK INDICATORS

A number of datasets were interrogated for indicators of fluvial flood risk:

- (i) The SFRA for the Athy Local Area Plan 2012 to 2018 does not detail any instances of historic or current flood risk within the vicinity of the Site.

Flood Risk Zones were established by Detailed FRA at locations within the Plan area; however, the Study Area was not subject to Detailed FRA.

- (ii) The OPW maintains the National Flood Hazard Mapping website which contains information about locations that may be at risk from flooding. The source of this information includes Local Authorities and other historic records such as newspaper articles and other documentation about reported floods. Flood events associated with the Barrow are noted although the extent of this flooding is not available (a copy of the summary report is included in Appendix A).
- (iii) Preliminary Flood Risk Mapping prepared for the CFRAM study programme indicates the Study Area is not impacted by fluvial flood risk during the 1000year flood (an extract from this mapping is included in Appendix B).
- (iv) Historical Ordnance Survey OS maps for the Site do not show any indicators of flood risk. Figure 4-1 shows the historic 25" OS mapping for the Study Area.

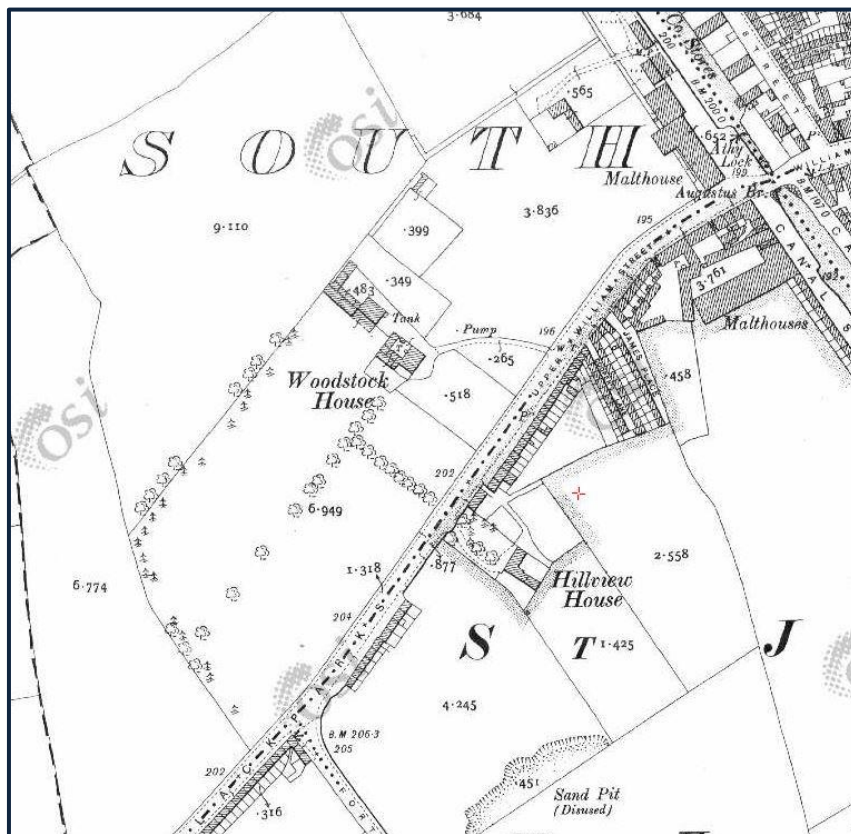


Figure 4-1 Historic 25" OS Mapping

- (v) A significant flood event occurred in Athy in November 2009 when the Barrow overtopped its banks.

Kildare County Council took a series of contemporary aerial photographs to record the extent of the fluvial flooding. Figure reproduces one of these photos which includes the Study Area. It can be seen that fluvial flooding does not impact on the Study Area.

Water can be seen lying on the agricultural lands west of the Study Area. These lands largely drain towards the Ballyadams River and thus away from the Study Area. The cause of this surface water is likely to be a combination of fluvial flooding, in the sense that it is in part caused by higher water levels in the Ballyadams River, and pluvial flooding, in the sense that it may be exacerbated by agricultural drainage not being capable of accommodating extreme rainfall event. This water does not impact on the Study Area.

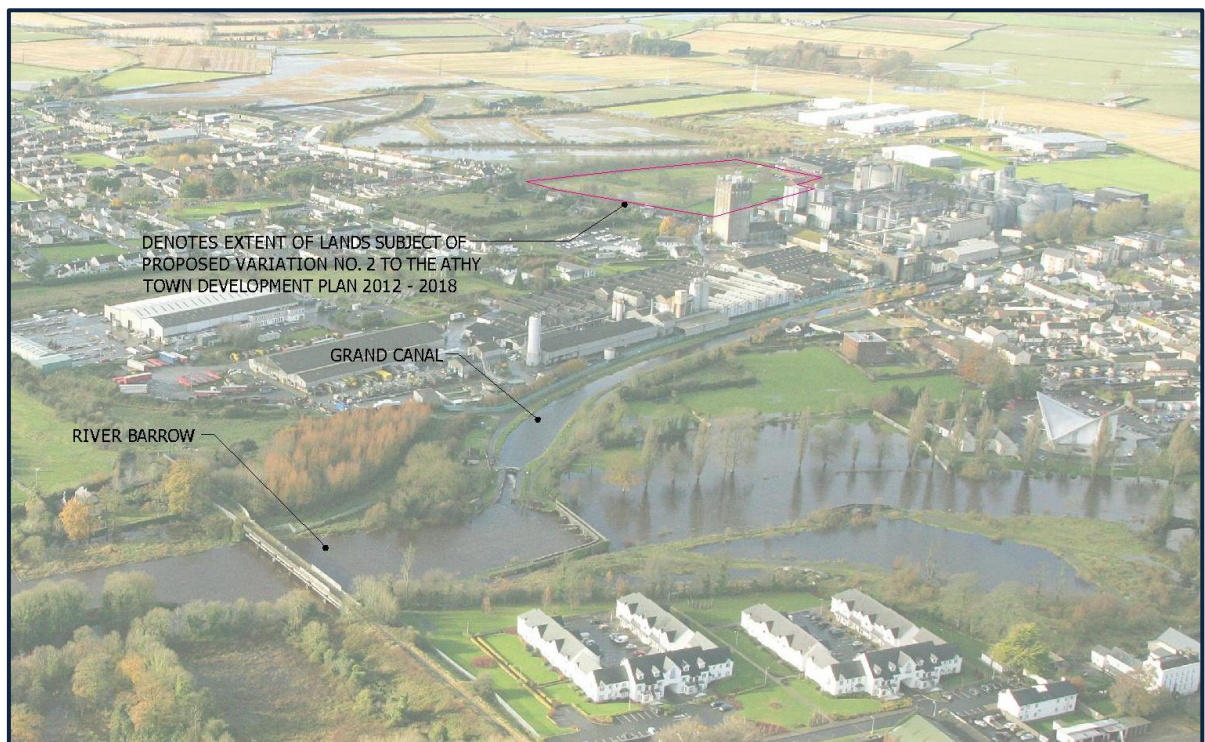


Figure 4-2 Aerial Photograph Taken During 2009 Flood Event

4.2 STAGE 1 ASSESSMENT

The available data as described in Section 4.1 does not provide any indication of fluvial flood risk in the Study Area such as would undermine a strategic decision to change the land-use classification as is proposed.

5. FLOOD RISK FROM GROUNDWATER

5.1 FLOOD RISK INDICATORS

A number of datasets were interrogated for indicators of flood risk from Ground Water. These comprise:

- (i) Records from the National Flood Hazard Mapping website maintained by the OPW do not contain any evidence of flood events at the Site associated with fluctuations in groundwater level
- (ii) The Geological Survey of Ireland (GSI) maintains a web portal for Groundwater Data (<http://spatial.dcenr.gov.ie/GeologicalSurvey/Groundwater>). The portal indicates that a regionally important aquifer of high vulnerability underlies the Site.

The portal indicates the subsoils in the Study Area comprise glaciofluvial sands and gravels of high permeability, which may be overlain in part by made ground.

- (iii) Ground investigations carried out within the existing facility indicate ground level only being encountered at depths of 1.5m or greater (Source www.gsi.ie – Report ID4462).
- (iv) Historical Ordnance Survey Historical OS maps for the Site do not show any indicators of flood risk from groundwater (Figure 4-1 shows the historic 25" OS mapping for the Study Area).

5.2 STAGE 1 ASSESSMENT

The groundwater flood-risk indicators described in Section 5.1 do not provide any indication of flood risk from groundwater in the Study Area such as would undermine a strategic decision to change the land-use classification as is proposed.

6. PLUVIAL FLOOD RISK

6.1 FLOOD RISK INDICATORS

A number of datasets were interrogated for indicators of pluvial flood risk:

- (i) The Study Area is on the western fringe of the urban area and west of the Barrow, which acts as ultimate outfall for all surface water run-off in Athy. It is therefore at the upstream end of any urban surface water drainage systems and not vulnerable to significant overflow run-off from urban surface water drainage.
- (ii) The photograph in Figure 4-2 shows water lying on agricultural lands west of the Study Area. These lands largely drain towards the Ballyadams River and thus away from the Study Area.

As already discussed in Section 4, the cause of this surface water is likely to be a combination of fluvial, in the sense that it is in part caused by higher water levels in the Ballyadams River, and pluvial, in the sense that it may be exacerbated by agricultural drainage not being capable of accommodating extreme rainfall event. This water does not impact on the Study Area.

- (iii) Records from the National Flood Hazard Mapping website maintained by the OPW do not contain any evidence of flood events at the Site associated with pluvial flooding;
- (iv) The Barrow Line of the Grand Canal is located approximately 200m northeast of the Study Area. Waterways Ireland has undertaken a PFRA with respect to the infrastructure that they own, operate and maintain and that could give rise to flood risk, e.g., embanked sections of canal. The process and outcomes of this work is detailed in the PFRA Report by Waterways Ireland. The conclusion of the work by Waterways Ireland is that the relevant infrastructure does not give rise to significant flood risk. Reasoning and details of this conclusion can be found in the aforementioned report. See Appendix C.

6.2 STAGE 1 ASSESSMENT

The pluvial flood-risk indicators described in Section 6.1 do not provide any indication of pluvial flood risk in the Study Area which would undermine a strategic decision to change the land-use classification as is proposed.

7. CONCLUSION AND RECOMMENDATIONS

A Stage 1 assessment of flood risk at the Study Area did not encounter any indications the Study Area is at risk from fluvial, pluvial or groundwater flooding such as would undermine the variation to rezone the Study Area from Zoning Objective R – Retail and Commercial: “To provide for and improve retailing and commercial activities” to Zoning Objective Q –“Enterprise and Employment”.

However, it is recommended that for any development within the Study Area, the surface water drainage system must include sustainable urban drainage measures in accordance with the Greater Dublin Strategic Study (GSDSDS) in order to ensure such development does not cause an increase in flood risk elsewhere.

It is also recommended that any development within the Study Area be designed in compliance with the Flood Risk Management Guidelines published by the Office of Public Works and subject to Site-Specific Flood Risk Assessment in accordance with these same Guidelines.

Appendix A

Summary report from OPW Flood Hazard Website

Summary Local Area Report

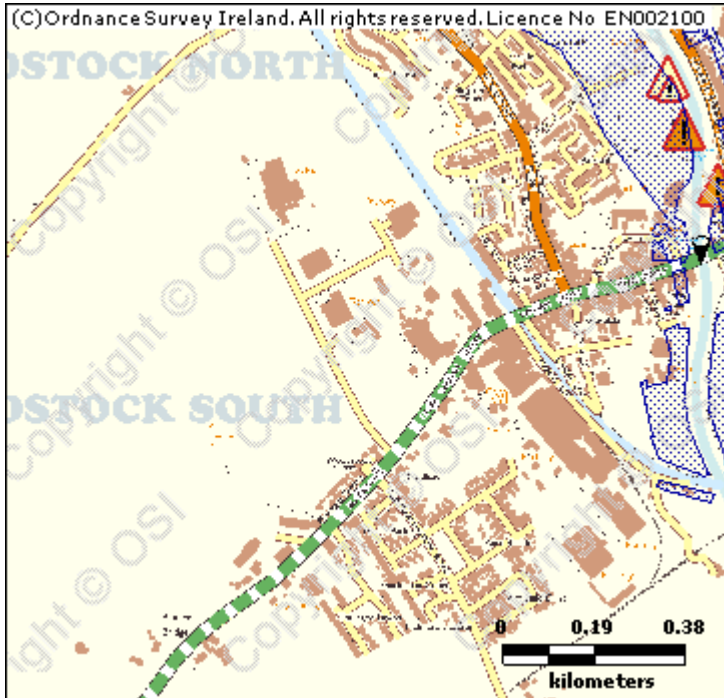
This Flood Report summarises all flood events within 2.5 kilometres of the map centre.

The map centre is in:

County: Kildare

NGR: S 675 937

This Flood Report has been downloaded from the Web site www.floodmaps.ie. The users should take account of the restrictions and limitations relating to the content and use of this Web site that are explained in the Disclaimer box when entering the site. It is a condition of use of the Web site that you accept the User Declaration and the Disclaimer.



Map Scale 1:15,532

Map Legend	
	Flood Points
	Multiple / Recurring Flood Points
	Areas Flooded
	Hydrometric Stations
	Rivers
	Lakes
	River Catchment Areas
	Land Commission *
	Drainage Districts *
	Benefiting Lands *

* Important: These maps do not indicate flood hazard or flood extent. Their purpose and scope is explained in the Glossary.

11 Results

	1. Barrow Athy February 1990 County: Kildare Additional Information: Reports (2) Press Archive (4) More Mapped Information	Start Date: 01/Feb/1990 Flood Quality Code:3
	2. Barrow Athy 18th August 2008 County: Kildare Additional Information: Reports (1) More Mapped Information	Start Date: 18/Aug/2008 Flood Quality Code:2
	3. Barrow Ardreigh, Athy Recurring County: Kildare Additional Information: Reports (1) More Mapped Information	Start Date: Flood Quality Code:2
	4. Barrow Athy Recurring County: Kildare Additional Information: Reports (2) Press Archive (9) More Mapped Information	Start Date: Flood Quality Code:3
	5. Athy Stream Clonmullin, Athy Recurring County: Kildare	Start Date: Flood Quality Code:3

Additional Information: Reports (1) More Mapped Information



6. Gallowshill Recurring

County: Kildare

Start Date:

Flood Quality Code:4

Additional Information: Reports (1) More Mapped Information



7. Gallowshill R418 Recurring

County: Kildare

Start Date:

Flood Quality Code:4

Additional Information: Reports (1) More Mapped Information



8. Gallowshill N78 Recurring

County: Kildare

Start Date:

Flood Quality Code:4

Additional Information: Reports (1) More Mapped Information



9. Rosbran Recurring

County: Kildare

Start Date:

Flood Quality Code:4

Additional Information: Reports (1) More Mapped Information



10. Ardreigh R417 Recurring

County: Kildare

Start Date:

Flood Quality Code:4

Additional Information: Reports (1) Press Archive (2) More Mapped Information



11. Barrow County Kildare Drainage Recurring

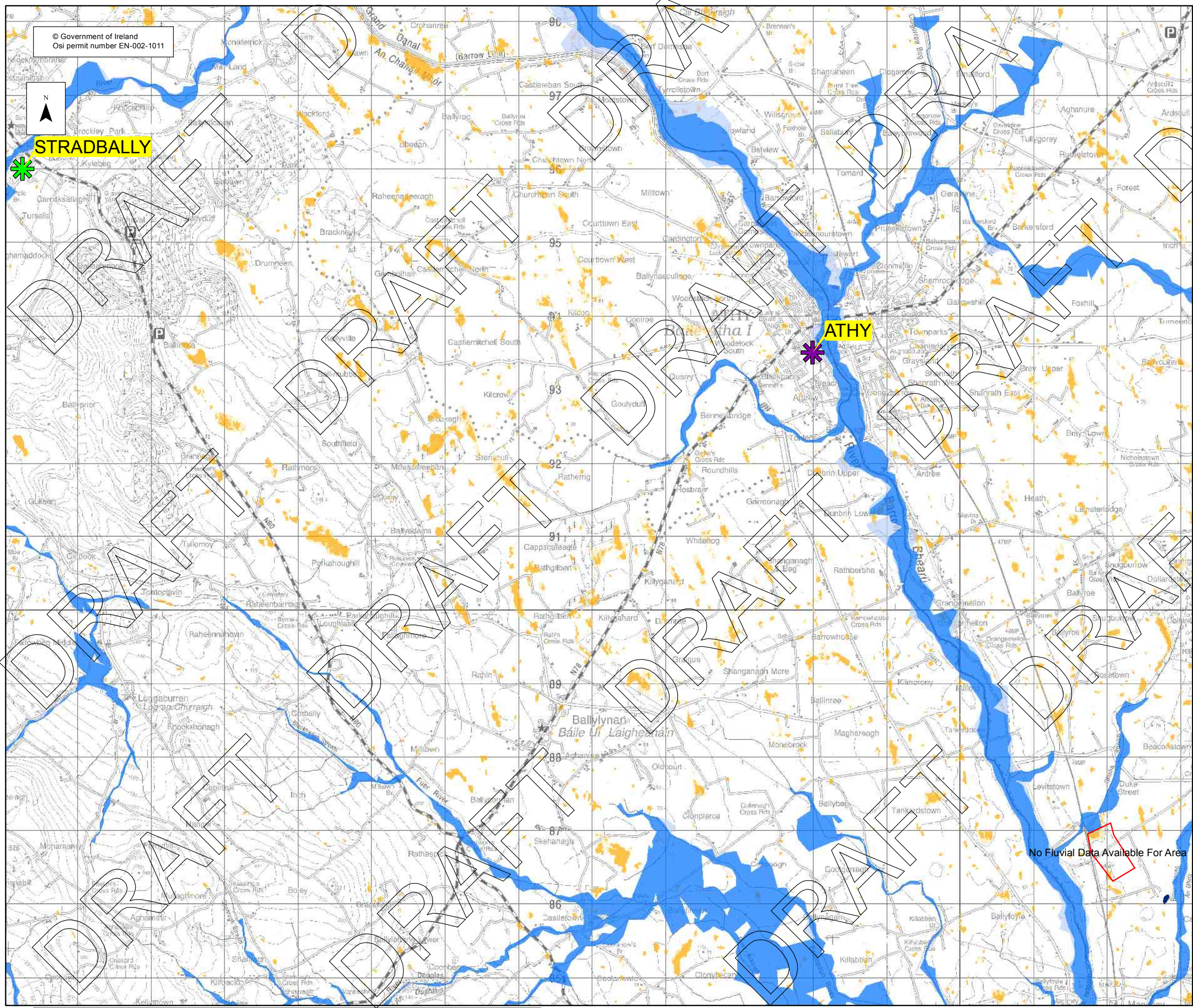
County: Kildare, Laois, Offaly

Start Date:

Flood Quality Code:3

Additional Information: Photos (3) Reports (3) More Mapped Information

Appendix B
PFRA Mapping



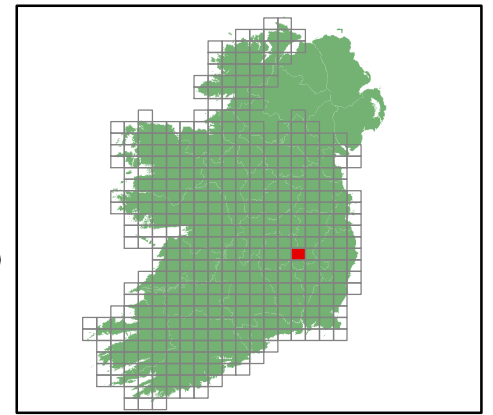
© Government of Ireland
Osi permit number EN-002-1011

STRADBALLY

ATHY

No Fluvial Data Available For Area

Location Plan :



Legend:

- Flood Extents**
- Fluvial - Indicative 1% AEP (100-yr) Event
 - Fluvial - Extreme Event
 - Coastal - Indicative 0.5% AEP (200-yr) Event
 - Coastal - Extreme Event
 - Pluvial - Indicative 1% AEP (100-yr) Event
 - Pluvial - Extreme Event
 - Groundwater Flood Extents
 - Lakes / Turloughs
- PFRA Outcomes**
- Probable Area for Further Assesment
 - Possible Area for Further Assesment

Important User Note:
The flood extents shown on these maps are based on broad-scale simple analysis and may not be accurate for a specific location. Information on the purpose, development and limitations of these maps is available in the relevant reports (see www.cfram.ie). Users should seek professional advice if they intend to rely on the maps in any way.

If you believe that the maps are inaccurate in some way please forward full details by contacting the OPW (refer to PFRA Information leaflets or 'Have Your Say' on www.cfram.ie).

Office of Public Works
Jonathon Swift Street
Trim
Co Meath
Ireland



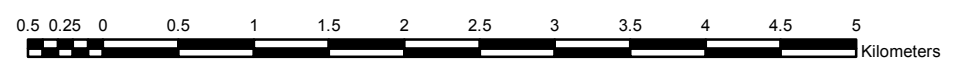
Project :
PRELIMINARY FLOOD RISK ASSESSMENT (PFRA)

Map :
PFRA Indicative extents and outcomes - Draft for Consultation

Figure By : PJW Date : July 2011
Checked By : MA Date : July 2011

Figure No. : 2019 / MAP / 184 / A Revision : 0

Drawing Scale : 1:50,000 Plot Scale : 1:1 @ A3



Appendix C

PFRA Report by Waterways Ireland

Preliminary Flood Risk Analysis Report

Waterways Ireland

18th July 2011

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Executive Summary

The statutory function of Waterways Ireland, the largest of the six North/South Implementation Bodies established under the British-Irish Agreement Act 1999, is to manage, maintain, develop and restore specified inland navigable waterways; the Barrow Navigation, the Lower Bann Navigation, the Royal Canal, the Erne System, the Shannon-Erne Waterway, the Grand Canal and the Shannon Navigation principally for recreational purposes.

The Statutory instrument transposing EU 'Floods' Directive into Irish law identifies roles for organisations such as local authorities, Waterways Ireland and ESB to undertake certain duties with respect to flood risk within their area of responsibility. Such risks must be identified through a preliminary flood risk assessment by December 2011. The PFRA is a high level screening exercise which involves collecting existing and readily available information on historic and potential floods, assembling it into a preliminary assessment report and using it to identify Flood Risk Areas which are areas where the risk of flooding is significant.

This report looks at the possible flooding mechanisms arising from the 'artificial water bearing infrastructure' and includes an analysis of historic flooding and potential future flooding of the Grand and Royal Canals and other smaller canals linked to the Shannon Navigation, the Lough Allen Canal, the Jamestown Canal and the River Blackwater / Erina-Plassey Canal.

Conclusion

The analysis of historic data shows that, while there have been incidences of flooding caused by failure of embankments and operational issues on the Grand and Royal Canals, they have generally occurred in rural areas with very limited damage to property. In only 2 cases a small number of houses and businesses were affected but for the remainder of cases the damage has been limited to temporary flooding of bog or farmland. In Tullamore and Edenderry the ground levels are lower than the canal in some areas and there is a potential for some flooding of property but the only area where the consequences of an embankment failure is relatively high is the embanked section of canal close to Mullingar, Co. Westmeath where up to 200 houses could be flooded. However this embankment has no history of failure, has been strengthened and partially lined in recent years, is inspected weekly for any sign of a potential breach and remedial action would be put in place immediately so while the consequences would be significant the likelihood of failure is extremely low and therefore this is not considered to be an area of significant flood risk.

Waterways Ireland is committed to continuing to work with the Office of Public Works and the ESB to deliver the Assessment and Management of Flood Risks on designated waterways as required by EC Dir 2007/60/EC.

1.0 Background and Introduction

Between 1998 and 2004 Europe suffered over 100 major damaging floods including the catastrophic floods along the Danube and Elbe rivers in Summer 2002. Further severe floods in 2005 further reinforced the need for a co-ordinated approach to the management of the problem. Since 1998 floods in Europe have caused up to 700 deaths, the displacement of 500,000 people and at least €25 billion in insured economic losses. Catastrophic floods endanger human lives and cause human tragedy as well as heavy economic losses and can have severe environmental consequences. Floods are natural phenomena but through the right measures it is possible to reduce their likelihood and lessen their impact.

Directive 2007/60/EC on the assessment and management of flood risks aims to reduce and manage the risks that floods pose to human health, the environment, cultural heritage and economic activity. Under S.I. 122 of 2010 European Communities (Assessment and Management of Flood Risks) Regulations 2010, the Statutory Instrument transposing the EU Directive into Irish Law, the Commissioners of Public Works in Ireland are appointed as the Competent Authority for flood risk management and other local authorities and organizations are named. Waterways Ireland, as the statutory body responsible for the majority of Ireland's inland navigable waterways, is obliged to undertake tasks the first of which is to prepare a Preliminary Flood Risk Assessment (PFRA) of the potential flood risk posed by the structural or operational failure of any of its infrastructure.

The PFRA is a high level screening exercise which involves collecting existing and readily available information on historic and potential floods, assembling it into a preliminary assessment report and using it to identify Flood Risk Areas which are areas where the risk of flooding is significant. This PFRA concentrates on flooding which has arisen or is likely to arise from the Royal and Grand Canals, classified in the legislation as 'artificial water bearing infrastructure'.

2.0 Waterways Ireland

Waterways Ireland is the largest of the six North/South Implementation Bodies which was established by means of an international treaty made on 8 March 1999 between the British and Irish Governments. This treaty was given domestic effect by means of the North/South Co-operation (Implementation Bodies) (Northern Ireland) Order 1999, and the British-Irish Agreement Act 1999 respectively.

As a Cross Border body, Waterways Ireland operates under the policy direction of the North / South Ministerial Council and the two Governments, and is accountable to the Northern Ireland Assembly and the Houses of the Oireachtas.

The statutory function of Waterways Ireland is to manage, maintain, develop and restore specified inland navigable waterways, principally for recreational purposes.

Waterways Ireland has responsibility for approximately 1,000 km of navigable waterways (Figure 1) comprising;

- the Barrow Navigation
- the Lower Bann Navigation
- the Royal Canal
- the Erne System
- the Shannon-Erne Waterway
- the Grand Canal
- the Shannon Navigation

Waterways Ireland's remit was extended by the North South Ministerial Council in July 2007 to include responsibility for the reconstruction of the Ulster Canal from Upper Lough Erne to Clones and following restoration for its management, maintenance and development principally for recreational purposes.

Of the water bodies listed above the artificial water bodies are the Grand Canal, the Royal Canal, part of the Shannon-Erne Waterway and a number of smaller canals linked to the Shannon Navigation namely the Lough Allen Canal, the Jamestown Canal and the Erina Plassey canal. The other navigation systems are a mix of River/Lake navigation with short lateral canals. Flooding on these systems is being dealt with under the fluvial PFRA being prepared by the Office of Public Works.

Ireland's Waterways



Figure 1

3.0 Potential Flooding Mechanisms

The possible flooding mechanisms arising from canal infrastructure are:

3.1 Failure or Breach of an Embankment

A large proportion of the Grand and Royal Canals are built in embanked sections running at a higher level than the surrounding countryside. These embankments were constructed of local readily available material, sometimes stone and clay but in some cases they are soft peat embankments which require considerable maintenance. Failure or breach of these embankments results in water from the level being released but the impact of the flood waters very much depends on the time of year and the level of saturation of the surrounding area. The tables in Appendix 1 & 2 shows the maximum volume of water which would be released by a failure of each of the levels of the Grand and Royal Canals.

3.2 Overtopping of the Banks

During periods of intense or prolonged heavy rainfall the volume of water running into the canal can exceed the volume of water which can be raked off using the overflows, the land tunnels and the gate sluices. This excess water overtops the banks and can cause flooding of surrounding areas if it cannot be discharged through the drainage network. The primary risk to the canal system of water entering at a rate which cannot be discharged or managed is that the canal water levels rise and will overtop. In embanked areas there is then a risk of failure particularly due to the erosion of the top bank level.

3.3 Operational Issues

Water has to be managed through the canal system to keep all levels at their optimum depth and sluices in the gates are used to carefully monitor the amount of water flowing from one level to the next. Overtopping from a long level to a shorter level can result in the shorter level being unable to discharge the volume of water and resultant flooding of the surrounding areas. Any failure of the lock-gates or interference with the sluices whether deliberate through acts of vandalism or accidental can result in overtopping of a short level as described above.

4.0 The Grand Canal



4.1 History of Construction

Work on the Grand Canal from Ringsend to the River Shannon, crossing the central plain and the Bog of Allen, commenced in 1756 and was complete to the Shannon in 1804. The canal is 182km long including the Branch Lines to Naas and Edenderry. The summit level at Lowtown is 40km west of Dublin and 85m above low tide at Dublin where there are 3 sea locks linking the Grand Canal Basin with the tidal River Liffey. The rise from Dublin to the summit is by way of 26 locks and the 50m fall to the River Shannon is by way of 18 locks over a distance of 93km. The average rise or fall of the locks is 3.0m while the largest is 5.7m at Inchicore Lock.

The Barrow Line of the Grand Canal is 45km from the summit at Lowtown to where it joins the Barrow River at Athy. The descent to the Barrow is by way of 9 locks, 2 of which are double-chambered.

There are 14 supply channels feeding the system at various lengths totally approximately 64km; the principal one being the Milltown supply from Pollardstown Fen which feeds the summit level. Most of the supply channels are artificially constructed and require constant maintenance particularly where they are embanked or through bog sections. From the summit level at Lowtown the canal begins its slow descent to Shannon Harbour where it joins the River Shannon. It passes through a varied landscape a particular feature of which is the high embankments with 24km through bogs.

4.2 Historic Flooding on the Grand Canal

4.2.1 Flooding due to embankment failure

Approximately 50% of the Grand Canal is built in embanked sections at a higher level than the surrounding countryside. These embankments were constructed in the late 1700s of readily available local material sometimes stone and clay but 24km are soft peat embankments which require considerable maintenance. There were numerous breaches of these embankments during the 1800s but none resulted in any significant flooding or damage to property, mainly due to the rural nature of the surrounding countryside much of which is bog.

The most significant breach of a peat embankment was the Edenderry breach in 1989 which occurred in a 31.5km level, the longest level of the Grand Canal. The Edenderry embankment, stretching from the Blundell Aqueduct to Downshire Bridge, is constructed entirely from turf, the only material available to the builders in the 18th century. When this section was first watered in 1797 it promptly collapsed and this was followed by further failures in 1800, 1855 and 1916. The most recent failure occurred in January 1989 when a large breach opened in the North bank about 950m west of the Blundell Aqueduct near the town of Edenderry. It is estimated that up to 135,000 m³ of water was discharged through the breach and 100,000 m³ of embankment material was displaced over a length of 300m; however, the damage to the surrounding land was comparatively minor. Approximately 12 acres of land were flooded with short term flooding of a further 36 acres including some football fields. This receded within a day and left little or no residual damage.

The failure was the result of a long length having become saturated over a period of many years. When the canals were commercially used 12 boats were continuously employed claying this section to avoid leaks. However, this ceased when the canals were closed to commercial traffic resulting in the peat becoming completely saturated and the continuing leaks causing piezometric pressure to build up near the base of the embankment. Long term wetting deteriorates the strength of the peat and eventually a point was reached, in this case, when the resistance due to the shear strength of the peat became less than the upward piezometric pressure resulting in a large wedge of the embankment simply floating away.

Similar breaches occurred in the Derries Embankment in 1955 and the Killeen embankment in 1975. In the former case the water was discharged to the Silver River in the immediate vicinity and the latter resulted in the flooding of some bogland. In August 1993 the partial collapse of a culvert at Hartley Bridge, Ticknevin, Co. Kildare resulted in the loss of approximately 30,000m³ of water. This did not result in any damage to land but did cause some inconvenience to 3 dwellings during the repair of the culvert.

4.2.2 Flooding due to overtopping and operational issues

There have been a number of minor flooding incidents caused by overtopping and operational issues.

- In the Bluebell area of Dublin city in November 2005 some damage was caused to 5 business premises due to vandalism at locks which resulted in bank overtopping.
- Some flooding occurred in Ardclough village near Celbridge, Co. Kildare in winter 2009 partly as a result of overtopping of the canal bank but no houses or businesses were affected.
- In Ballycommon, Co. Offaly in August 2008 during a period of intense heavy localised rainfall the large diameter pipes under the towpath could not take the flow from the surrounding high ground and the water entered the canal flowing over the towpath. The volume of water entering the canal exceeded the volume of water which was being discharged via the sluices, overflows and racks. At the time there was a significant risk of overtopping and emergency services were put on alert but no damage occurred.

4.3 Inspection and Maintenance Regime

When a breach occurs dams are installed immediately to reduce the loss of water and the embankment is repaired. In the case of the 1989 Edenderry breach the section of embankment was completely rebuilt and lined and, as a result of the lessons learned, peat embankments are now inspected regularly for any signs of damage or leaks and there is an ongoing program to strengthen them and line them where necessary to reduce the risk. In addition a stop chamber was constructed at Rathmore which reduces the length of the level likely to be affected by another breach of this embankment to 8km and so the amount of water which would be discharged would be 25% less than was discharged in 1989.

Water is carefully managed throughout the system and all locks are inspected regularly to ensure that the water management regime is in order. Where there is a risk or history of vandalism, locks are placed on the sluices to prevent interference. Where banks have limited freeboard there is an ongoing program to raise them to increase the carrying capacity of the canal and there is also an ongoing maintenance program for overflows and back-drains.

4.4 Potential Future Floods

The majority of the Grand Canal runs through remote rural areas much of which is bog and so flooding will result in limited damage. The canal passes through a number of villages and 2 towns Edenderry and Tullamore.

Edenderry town ground levels are below canal water level and the toe of the embankment has been damaged in the past due to industrial activity particularly in the Edenderry Business Park. A catastrophic failure of this embankment could have serious consequences to property due to the volume of water contained in the 31.5km level and the topography of the area; however, some of the risk has been mitigated by the introduction of the stop chamber, the works done to the embankment and the regular inspections of the embankment.

The ground levels in some areas of Tullamore town are also below canal water level. The embankments here are intact but continuous development alongside the canal including underground services could impact on the structural stability of the canal embankments. A breach in the Tullamore area would have serious effects on property however, continuous monitoring and maintenance regimes are in place and a breach is thought to be unlikely in this area.

Appendix 1 lists all reaches of the Grand Canal system giving dimensions, embankment details, inflows and potential flooding volumes.

5.0 The Royal Canal



5.1 History of Construction

The Royal Canal was the second canal to be built across the country from Dublin to the River Shannon. Work started in 1790 and the canal reached the Shannon in 1817. Spencer Dock in Dublin was not complete until 1873. The navigation starts at Spencer Dock and the canal rises steeply out of the city through a succession of double locks. From the 10th lock, although still in Dublin, it begins to assume a rural aspect through an attractive tree lined stretch. It climbs up to a summit level through Mullingar at 94.3m higher than the entry level at Spencer Dock, then drops down to the River Shannon at approximately 40m above sea level. The canal is 146km in length with 46 locks 10 of which are double chambered and there is also a sea lock where the canal joins the River Liffey in Dublin. Approximately 55% of the Royal canal is embanked with 3 peat embankments at Cloonbreany, Begnagh and Ballymaclavy and a 3km embankment running around the town of Mullingar, Co. Westmeath. The Royal Canal was closed to navigation from 1960 and was only fully reopened in 2010 following a lengthy period of reconstruction.

5.2 Historic Flooding on the Royal Canal

5.2.1 Flooding due to embankment failure

The only significant breach of the Royal Canal embankments in recent years occurred in June 1993 on the 32.4km long level of the Royal Canal near the Longwood Aqueduct at Ballycooley, Longwood, Co. Meath. The breach was approximately 15m wide and occurred in a 6m high embankment. The water flowed through the breach into a low-lying strip of waste land and from there through a culvert under the railway and flooded a lane and some fields. A large area of land was flooded however the floods receded within 2 days and the breach did not result in any significant damage. A similar breach occurred in this area in the 1920s.

5.2.2 Flooding due to overtopping and operational issues

The most significant flooding due to overtopping was in the Spencer Dock area in Dublin city in 2002 when, due to the very high tide levels, the River Liffey was 0.4m higher than the level in the Royal Canal. The water flowed back up the Royal Canal and caused flooding of a maximum of 20 houses and 5 business premises.

Other flood events were extremely minor in nature Maynooth Harbour has occasional flooding of 1 garden if sluices in the lock gates are not left in the correct position and there is also occasional flooding of the road east of Darcy's Bridge and near Ferns Lock.

5.3 Remedial Action

Immediate repairs were made to the Longwood embankment which was rebuilt and sealed with a HDPE liner and puddle clay. The embankment is inspected regularly for any signs of a further breach.

In Spencer dock a new sea lock and flood protection system was constructed so that high tides can no longer cause this type of flooding.

5.4 Inspection and Maintenance Regime

All of the embankments in the Royal Canal are inspected regularly. Because of the level of risk the Mullingar embankments are inspected weekly while the Longwood, Downs and Ballymaclavy embankments are inspected monthly. Any necessary repairs are carried out immediately.

5.5 Potential Future Floods

The only area of potentially significant flood risk identified by this study is Mullingar where up to 200 houses could be flooded in the event of a failure of the embankment however

- this embankment has no history of failure
- has been strengthened and partially lined in recent years
- is inspected weekly for any sign of a potential breach
- remedial action would be put in place immediately

while the consequences of failure would be significant the likelihood of failure is extremely low and therefore this is not considered to be an area of significant flood risk.

Appendix 2 lists all reaches of the Royal Canal system giving dimensions, embankment details, inflows and potential flooding volumes.

6.0 Lough Allen Canal

6.1 History of Construction

The Lough Allen Canal is approximately 7.4Km long. It was constructed in the early 19th century to connect the Shannon Navigation at Battlebridge to Lough Allen at Drumshanbo Bridge through Acres Lake, near Drumshanbo. The canal fell into disuse after 1933 but was restored and reopened as far as Acres Lake in 1977 and fully reopened to Lough Allen in 1995.

Datum Levels (Poolbeg)

Ordinary summer Level for Lough Allen is 48.16m OD.

The canal is formed on two levels, (1) Drumshanbo to Acres lake to Drumleague Lock 3.18km at OSL of 49.85m. OD and (2) Drumleague to Battlebridge, a length of 2.67km at OSL (Ordinary Summer Level) of 46.45m OD

The Ordinary Summer level downstream of Battlebridge lock is 42.98m

6.1.1 Storage capacity

The volume of water stored at Level 1 is 221.7×10^3 cubic metres. The volume of water stored at Level 2 is 57.6×10^3 cubic metres. In times of low water, the level is maintained by an intake pumps. In times of heavy rainfall, levels are reduced by gravity flow through lock gate and land sluices.

6.2 Historic flooding on the Lough Allen Canal

While there is a historical reference to bank failure in 1876, the raised embankment section of the Lough Allen canal performed satisfactorily in recent flooding events.

6.3 Inspection and Maintenance Regime

Water Levels are managed daily by experienced personnel. Inspection regimes are in place to carry out regular inspections of the canals and amenities. Maintenance programmes are in place to address reported defects.

During a flood event water levels are monitored daily and sometimes hourly and water levels are managed to reduce pressure on the banks.

6.4 Potential Future Floods

Specifically, in consideration of potential floods arising from Waterways Ireland infrastructure and not from river flooding, the potential risks are associated with failure of raised canal banks, failure of lock gates, and potential vandalism, neglect or human error.

There is 3.18km of raised bank on Level (1) and 2.40km of raised bank on Level (02). This represents 35% and 45% of the canal banks respectively.

7.0 Jamestown Canal

7.1 History of Construction

The Jamestown Canal is located just south of the village of Jamestown on the Roscommon side of the Shannon. The canal is approximately 2.7km long. It was originally constructed in 1754 and upgraded in 1845. As a lateral canal the water level is determined by the upper region and is the same as the Carrick-on-Shannon to Jamestown stretch with an OSL of 42.98m OD. 24% of Jamestown canal is raised bank.

7.1.1 Storage capacity

As a lateral canal, the canal level is determined by the River Shannon, and therefore Jamestown Canal will be incorporated in the River Shannon Assessment.

7.2 Historic Flooding on the Jamestown Canal

The canal does not contribute to flood relief. During the 1999/00 and 2009 floods, temporary dams were required to reduce pressures on the canal banks.

7.3 Inspection and Maintenance Regime

Water Levels are managed daily by experienced personnel. Inspection regimes are in place to carry out regular inspections of the canal and amenities. Maintenance programmes are in place to address reported defects.

Appendix 3 contains summary details and dimensions.

8.0 Shannon Navigation – River Blackwater

8.1 River Blackwater

The River Blackwater is a small tributary of the River Shannon which joins the latter on its right bank about 2 miles upstream of Limerick City. The catchment area covers 15,500 acres and is entirely in Co. Clare with the village of Clonlara almost in the centre. From the southern slopes of the Slieve Barnagh range of hills the several streams which form the river flow from north to south where it then passes under the Headrace of the Ardnacrusha generating station west of Clonlara and thence in a south-westerly direction to join the Shannon. Most of the area is steeply sloped having Knockanuartha (1017ft) and Knockaphunta (845ft.) on its watershed. The lowlands (about 40ft) are just 10miles from the farthest point on the watershed. Due to the very steep slope of the catchment the river responds extremely quickly to rainstorms. Rainfall in the upper reaches discharges into the lowland area in about 2 ½ hrs after the commencement of a storm resulting in floods of high intensity and short duration causing damage to several hundred acres of land and at times flooding buildings.

8.2 Errina Plassy Canal

When the Commissioners of Inland Navigation and / or the Limerick Navigation Company in or about 1770 were making the River Shannon navigable from the head of the tideway at Limerick to Lough Derg they constructed a 6 ½ mile long lateral canal between Plassy and Errina just downstream of O'Briensbridge to overcome the falls at Doonass and Castleconnell. A supply of water from the Canal was taken from the River Shannon at the upstream end and near Errina. No other water was carried in the Canal. There were 6 navigation locks to overcome a total lift of about 56 feet. The Canal was not finally completed by the Directors General of Inland Navigation until about 1812. Ownership passed to the Limerick Navigation Company in 1829, to the Shannon Commissioners in 1839 to the Commissioners of Public Works in 1846 and to Waterways Ireland in 1999.

The Canal has not been used for navigation since 1930 when the Shannon Hydroelectric Scheme rendered the waterway unusable as a route to Lough Derg and a new navigation was incorporated in the Headrace Canal of the generating station.

The route of the Canal passes through the lower catchment area and flood plain of the River Blackwater. For topographical reasons it was not possible to carry the canal through the flood plain by aqueduct over the River Blackwater. The latter was diverted a short distance downstream of Mountcatherine Bridge, and both River and Canal were turned in a south-westerly direction to discharge into the Shannon at Plassy. Both run parallel and are separated by the canal's right embankment for the entire length of the diversion. This embankment retained the Canal's operating water level which in summer was higher than the diverted river. During flood periods however the river level used to rise higher than the Canal's level and can overtop the Canal embankment in extreme conditions.

As part of the diversion works embankments and a sluice were also constructed along both banks of the River Blackwater diversions as far as the diversion point which is also the upstream limit of Waterway Ireland's jurisdiction for Navigation purposes. Upstream of the diversion point and on both banks of the River Blackwater these embankments are continued to higher ground just downstream of Mountcatherine bridge. It is not known by whom the latter were constructed or where responsibility for their maintenance rests. Waterways Ireland however carries out repairs from time to time on the embankments downstream of the diversion point. In 1984 a landowner removed part of the embankment on the left bank of the River Blackwater just downstream of Mountcatherine Bridge, leaving a large gap in the flood defence works and contributing to a large extent to the flooding of the 5th / 6th August 1986.

The purpose of the river embankments was to divert all the upland water upstream of Mountcatherine Bridge along the new channel and to protect the Canal from flooding. This conferred valuable immunity from flooding on the low lying lands of the Blackwater through which the Canal is carried as long as the embankments from Mountcatherine Bridge to Plassy are not breached or overtopped. Even if they are the extent of flooding cannot be as great as would be the case had the Canal not been constructed since the diversion carries the bulk of the Blackwater's discharge away from the old course. The new channel is $\frac{3}{4}$ mile shorter than the old course which was extremely tortuous and must have been inefficient to cater for any flood.

No records survive to indicate ancillary works carried out affecting the drainage of the low lying lands on either side of the Canal in the townlands of Mountcatherin, Newtown, Springfield and Cappavilla North. In times of flood the River Shannon backwaters along those drains and can cause flooding. The old course of the River Blackwater was abandoned but the outfall section from the River Shannon to a point about 1 mile south-east of Newtown Lock was retained to drain the balance of the Blackwater catchment not served by the diversion. The lands on either side of the canal are extremely low lying and of poor quality. Moderate rainfall causes waterlogging or flooding due to the small gradient and poor condition of the channels.

As the canal level is determined by the River Shannon it will be dealt with as part of the River Shannon study.

8.3 Past Floods on the River Blackwater

Flooding of 5th/6th August 1986

Exceptional rainfall occurred throughout the Southwest and eastern parts of the country on the night of 5th/6th August 1986 when there was record rainfall in Counties Kerry, Cork, parts of Limerick and Dublin. However the storm was less intense when it reached east Limerick and Clare. The following rainfall fell in a period of 12 hours, Ardnacrusha 40mm, Parteen 46.6mm and Shannon Airport 35.5mm. The Metrological Service stated that the rainfall could have been as high as 50mm in the Clonlara area and considerably higher in the upper reaches of the Blackwater.

The discharge in the River Blackwater as a result of the rainstorm appears to have been exceptionally high. The flood peaked in the early hours of the 6th August and an estimate of the peak discharge was recorded as 2,500 cusecs.

Part of the discharge flowed directly through a breach in the left bank where a local landowner had removed a large section of embankment. In doing so one dwelling house and office was flooded to a depth of 2 and a half foot while another house was flooded to a depth of 6 inches.

Further downstream there was more flooding on the left bank as a result of damage to the embankments by cattle but no houses were affected.

8.4 Remedial Action

The embankments were repaired.

8.5 Inspection Regime

The banks are inspected regularly, once weekly and necessary repairs, removal of trees and debris carried out. The banks are also checked after high winds and heavy rain.

8.6 Potential Future Floods

If the embankment was breached at the same location again, then there is the potential for more flooding of dwelling houses. There are now 27 houses at that location and, depending on their floor levels, some or all of those could be at risk of flooding. This falls outside the significant flood risk as defined for the PRFA Report.

The Inspection Regime mentioned above is in place and there was no flooding at this location in the extreme flood event of 2009.

Appendix 1

Grand Canal Lengths and Estimated Flood Volumes

	Level Name	Water Level	Length	Est embanked length	Embankment Condition	Depth	Avg Width	Volume	Spread Radius	Overflows	Receiving Water	Intakes to Canal	Historic Flooding	
		mOD				km	(m)		m					
Grand Canal Dock	GCD	3.39	1.2	0		4.5	80	432000	742			DCC Stormwater outfall Ringsend		Ringsend Sea Lock & Grand Canal Docks
Circular Line	C1	4.12	0.2	0		2.02	12	4836	78					Maquay Br.
Circular Line	C2	6.98	0.2	0		2.20	12	5268	82					Lr. Mount Street
Circular Line	C3	9.85	0.4	0		2.21	12	10613	116					Upr. Mount Street
Circular Line	C4	12.45	0.6	0		2.06	12	14803	137					Baggot Street
Circular Line	C5	15.13	0.6	0		1.96	12	14119	134					Leeson Street
Circular Line	C6	18.05	0.4	0		2.10	12	10094	113					Charlemont St.
Circular Line	C7	20.68	2.4	0		1.97	12	56707	269					Portobello
Main Line	1	24.90	0.6	300 NB	Fair	1.99	12	14328	135					Suir Road Bridge
Main Line	2	28.90	1.0	90 NB	Fair	2.65	12	31848	201	Overflow below 3rd Lock	Camac River			Goldenbridge
Main Line	3	34.87	0.4	0		1.98	12	9494	110					Blackhorse Bridge
Main Line	4	38.80	0.4	400 NB Slightly embanked	Fair	1.96	12	9427	110					
Main Line	5	41.90	0.4	400 NB&SB Slightly embanked	Fair	2.61	12	12504	126	Take-off point Dublin City Council above 5th Lock. Take-off point for CIE	DCC / CIE			
Main Line	6	45.21	0.8	600 slightly embanked SB	Fair	2.04	12	19613	158				Flooding of 5 no. businesses occurred including some damage due to vandalism at locks and bank overtopping Nov 2005 - measures since taken to reduce risk of this re-occurring	
Main Line	7	48.89	0.8	130 NB&SB	Fair	1.97	12	18912	155					Ballyfermot Bridge
Main Line	8	51.59	1.8	0		2.19	12	47347	246	Take-off point Dublin City Council at Filter beds above 8th Lock	DCC			
Main Line	9	56.16	0.4	500	Fair	2.05	12	9835	112					Clondalkin Bridge
Main Line	10	59.32	0.4	180	Fair	2.28	12	10925	118					
Main Line	11	62.47	3.0	0		2.02	12	72648	304	Griffeen Overflow	Griffeen River			
Main Line	12	66.05	7.4	1400 NB 450 SB	Fair	1.99	12	176534	474	Behans overflow	Shinkeen River			Lucan Road Bridge
Main Line	13	71.16	6.0	1250 NB 900 SB	Fair	2.05	12	147600	434			Morrell below lock 14	Flooding occurred in Ardclough village in winter 2009, canal bank overtopping likely contributing to this - the bank has since been raised.	
Main Line	14	73.12	0.6	180 NB 0 SB	Fair	2.06	12	14810	137					Devonshire Bridge
Main Line	15	75.73	7.2	600 NB 320 SB	Fair	2.01	12	173837	470	Lein Aqueduct overflow / overflow to Morrell @ 15th Lock	Liffey & Morrell Rivers	Monread east of Sallins		
Main Line	16	78.32	1.0	0		1.94	12	23340	172					Digby Bridge
Main Line	17	81.07	1.4	90 NB	Fair	2.07	12	34810	211					Landenstown Bridge
Main Line	18	82.45	6.6	1100 NB 900 SB	Poor	1.93	12	152777	441			Milltown Feeder		Bog of Moods Roberstown
Naas Branch	Naas	varies	5.0	0		2.00	12	120000	391	Overflow Between Locks N2 & N3	From bypass drain / Rathasker	Rathasker in Naas Harbour		
Corbally Branch	Corbally	n/k	8.0	1200WB 200 EB		1.50	12	144000	428	2 Overflows	Via drains to Liffey	2 Intakes - Corbally Harbour & Hoares Bridge		
Main Line	19								0					Lowtown (Summit Level)
Main Line	20		14.5	12500	2500 Soft	2.00	12	348000	666		Gravity Overflow to Slate River		Aug 93 Approx 20000 - 30000 cumecs flooding 3 houses inconvenienced during replacement of culvert	Allenwood
Edenderry Branch									0					Edenderry Harbour
Main Line	21		31.5	25500	22500 Soft	2.00	12	756000	981	Overflows to Boyne, Barrow & Tullamore/Brosna		7 Uncontrolled drains between Daingean & Ballycommon		Edenderry / Daingean
Main Line	22		1.4	1400	Solid	2.00	12	33600	207	Overflow to Tullamore / Brosna Rivers				Ballycommon
Main Line	23		0.6	600	Solid	2.00	12	14400	135	Overflow to Tullamore / Brosna Rivers				Capperoe Bridge
Main Line	24		3	300	Solid	2.00	12	72000	303	Overflow to Tullamore / Brosna Rivers				
Main Line	25		0.6	600	Solid	2.00	12	14400	135	Overflow to Tullamore / Brosna Rivers				
Main Line	26		0.8	800	Soft	2.00	12	19200	156	Overflow to Tullamore / Brosna Rivers				Cappincur Bridge
Tullamore Branch									0					Tullamore Harbour
Main Line	27		3	2500	1500 Soft	2.00	12	72000	303	Overflow to Tullamore / Brosna Rivers				Tullamore
Main Line	28		0.4	400	Solid	2.00	12	9600	111					
Main Line	29		3.4	3400	Solid	2.00	12	81600	322	Overflow to Tullamore / Brosna Rivers				Ballycowan Bridge
Main Line	30		7	7000	Solid	2.00	12	168000	462	Overflows to Tullamore, Clodiagh/Brosna Rivers		Newtown Supply		Ballinloughin Bridge
Main Line	31		0.8	800	Solid	2.00	12	19200	156	Overflow to Brosna				Cornalour Bridge
Main Line	32		15.6	14800	14000 Soft	2.00	12	374400	690	Overflow to Silver Brosna Rivers		Derrycooley Supply		Pollagh
Main Line	33		2	2000	Solid	2.00	12	48000	247	Gravity Overflow to Brosna				Belmont Bridge
Main Line	34		3.6	2800	Solid	2.00	12	86400	332	Brosna River				Clononey Bridge
Main Line	35		2	800	Solid	2.00	12	48000	247	Brosna / Shannon Rivers				Shannon Harbour
Main Line	36		0.4	200		2.00	12	9600	111					Junction with Shannon
Barrow Line	19		2.6	500	Fair	2.0	12	62400	282					Lowtown
Barrow Line	20		3.4	800	Fair	2.0	12	81600	322					
Barrow Line	21		0.2	200	Fair	2.0	12	4800	78					
Barrow Line	22		4.8	4800	Fair	2.0	12	115200	383			White Eye Supply		
Barrow Line	23		4.8	2600	Fair	2.0	12	115200	383					Rathangan
Barrow Line	24		7.6	3600	Fair	2.0	12	182400	482					
Barrow Line	25		2.4	1000	Fair	2.0	12	57600	271					Monasterevin
Barrow Line	26		21.0	8000	Fair	2.0	12	504000	801			Annaknock Supply		
Barrow Line	27		0.8	0		2.0	12	19200	156					
Barrow Line	28		0.4	0		2.0	12	9600	111					Athy

Notes: NB - North Bank SB - South Bank Occasional ponding around at locks during boat movements - not considered as flooding