# 09 - THE RIVER TOLKA FLOOD STUDY 10 YEARS ON - A CASE STUDY ON HOW CATCHMENT BASED FLOOD RISK MANAGEMENT WORKS

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**Abstract**
What happens after a catchment flood risk management plan is completed? The Tolka Flood Study was commissioned in 2002 to provide a detailed analysis of the River Tolka, Castle Stream and Twin Pinkeen Streams. It was a catchment based flood risk management study undertaken in Ireland. In order to comply with Water Framework Directive, an integrated catchment management approach was applied, which considered how to manage the quantity of water and improve the quality of water resources in the catchment whilst also providing flood alleviation for existing development at risk. Ten years after the plan was first published, we ask: have the objectives been achieved and has the plan been implemented, and if so, how are the works performing?

***Figure 1:*** *Flooding in 1954 Fairview*

## 1 INTRODUCTION

The Tolka Flood Study was an extension of the 2001 – 2005 Greater Dublin Strategic Drainage Study (GDSDS), the objective of the Tolka Flood Study was to provide a comprehensive flood analysis of the River Tolka and major urban and rural tributaries. The analysis included the development of a robust hydraulic and hydrological model representing the characteristics of the River Tolka catchment. The model output provided flood risk mapping for design rainfall events. A Flood Alleviation Strategy was developed using this model output and also took account of climate change and possible future land developments.

During the study (November 2002) a significant flood took place, the second flood event in as many years. A report was produced that defined the history of flooding in the River Tolka, utilised the relevant historic data available to develop a profile of flood risk for the catchment and summarised the outcome of modelling studies, related to the 2002 and previous flood data, in order to quantify flood risk. It summarised options available for flood alleviation in the catchment and identified an integrated series of measures, which were recommended for implementation in order to manage flood risk based on technical, environmental and economic assessment.

The Tolka Flood Study Report contained a number of measures on how to achieve the objectives. In order to implement the measures a number of stakeholders were involved. These included RPS as

Consultant Engineers, the OPW, Dublin City Council, Fingal County Council, Meath County Council, the National Roads Authority and Inland Fisheries. The Tolka catchment covers a number of local authority areas and hence the involvement of the various Councils.

### 1.1 Catchment Description

The Tolka River is the second largest river to enter Dublin in terms of its length and catchment area, after the River Liffey. The river rises west of Dublin in County Meath near the Culmullin Cross Roads on the R125 roadway, and is fed by a network of small tributaries as it flows through Batterstown, Rathbeggan, Quarryland, Piercetown, Blackbull, Dunboyne, Clonee, Mulhuddart, Blanchardstown, Finglas Bridge, Glasnevin, Drumcondra, North Strand and East Wall to enter the sea east of the DART depot at Fairview Park.

The Tolka River has a catchment area of 14,150 hectares, and drops 140m in 33.3 kilometres. The upper-catchment can be described as predominantly rural. The river in this area is little more than a stream with small meanders and flatter banks with a relatively flat slope of about 0.4 %. It is roughly 2.5m wide near Batterstown and only 5m wide just upstream of Clonee Bridge. Despite this, the area was subject to occasional flooding with the plain extending up to 400 meters wide in these areas.

The profile of the river changes noticeably as it drops from an open, rural catchment upstream of Clonee into the major urban environments of Mulhuddart, Blanchardstown and Ashtown. The river through the formalised Tolka Valley Park, Botanic Gardens and Griffith Park becomes somewhat wider and straighter, with generally higher and more defined grass banks. In its latter reaches through Glasnevin, Drumcondra and Marino, the river becomes increasingly channelised, which is characteristic of many urban rivers, where development extends almost to bank top. In addition, the area below Drumcondra has a tidal influence.

## 2 RIVER TOLKA FLOODPLAIN MANAGEMENT PLAN

The study process involved a floodplain management plan be developed for the River Tolka as part of an overall catchment management plan, in the context of implementing the Water Framework Directive to encompass:

- Publication and maintenance of flood risk mapping as developed in this study.
- An updated flood awareness and emergency planning scheme.
- Flood forecasting and flood warning arrangements including real-time rainfall and water level/flow monitoring linked to the Dublin City Council telemetry system.
- Arrangements at local level, to be put in place by the Local Authority in conjunction with Residents Associations for local flood protection measures and safe fail systems in the event of a flood situation.
- An ongoing programme of monitoring and maintenance of the River Tolka channel and its ancillary structures.
- Systematic implementation of Sustainable Drainage Systems (SuDS) for new development in the catchment.
- Co-ordinated planning and building control between the three Authorities in order to conserve riparian corridors along rivers, prevent as far as practicable development within the floodplain (ideally 1:100 year floodplain extent and a minimum of 1:50 year floodplain limit) and to

ensure that redevelopment of "brownfield" sites incorporate appropriate measures to eliminate flood risk for such developments.

- Any new developments which are required to be implemented in the floodplain of the river must be subject to flood impact assessment and must demonstrate that their implementation will not increase flood risk elsewhere in the catchment.

***Table 1:*** *Recommendation from River Tolka Flood Study Report and Responsible Organisation*

| Element of Work | Responsibility – Who carried out the Work |
|---|---|
| Floodplain Mapping | RPS Consulting Engineers with Dublin City Council |
| Flood awareness and emergency planning | Dublin City Council, Meath County Council & Fingal County Council |
| SuDS - Sustainable (urban) Drainage Systems | Dublin City Council, Meath County Council & Fingal County Council |
| Planning and Building Control | Dublin City Council, Meath County Council & Fingal County Council OPW |
| Embankments and retaining walls, | Dublin City Council, Meath County Council & Fingal County Council OPW, Developer |
| Attenuation Ponds | Dublin City Council, Meath County Council & Fingal County Council OPW |
| Maintenance of the Watercourse | OPW or Local Authorities |

Flood awareness and emergency planning: As part of the study the maps produced were used to assist the local authorities in writing the Emergency Response Plans for Flooding for the catchment area. The OPW as part of their lead agency role published in 2009 a protocol and guidance on how to write this plan. In 2013 this guidance and protocol were revised by the OPW, updated and published with lessons learned by the emergency response teams incorporated, refer www.mem.ie .

As part of the overall Greater Dublin Strategic Drainage Study, new guidance for planning and development incorporating SuDS was produced. The GDSDS principal drainage policy objectives were subsequently adopted in the Development Plans for the Region, and a Regional Code of Practice is now in use by the Dublin Region Local Authorities. This ensures that any new development within the catchment does not contribute to the already existing flood risk. It has also ensured that Local Authority Planners can stipulate that any flood storage removed is compensated within the proposed development. Dublin City Council as part of the Greenways Project supported by the National Transport Authority have constructed a number of new wetland ponds in the Tolka Valley park this year. This project is a primary example of SuDS being applied to the Tolka Catchment.

Planning System and Flood Risk Management Guidelines jointly published in 2009 by the Department of the Environment and Local Government and the OPW have introduced new national guidelines for planners to consider flooding when zoning lands and granting planning permission. This has delivered on the element of the study relating to Planning and Building control and is applicable nationwide and not just in the Tolka Catchment.

Flood forecasting for the River Tolka was considered, but due to the short reaction time it was not considered a viable option. This does not mean that there should not be hydrometric monitoring of the

catchment. In order to monitor the flows in the river two special flow measurement weir structures were constructed as part of the flood alleviation scheme. One of these structures is in the upper end of the catchment opposite the Keepac factory in County Meath and the second is located at the site of the original Fingal Weir at the upstream side of Finglas Road bridge. Neither of these two structures have had telemetry added to them or ratings measured and hence no data has been gathered. In the Botanic Gardens, the EPA have continued to operate a hydrometric gauging station. Dublin City Council, funded by the OPW, have installed a Tidal Gauge at the upstream end of Alfie Byrne Road in East Wall. This data feeds into the Irish National Tide Gauge Network managed by the Marine Institute. Their are several contributors to this tidal network project from a number of different public and private organisations.

## 3 CATCHMENT MANAGEMENT PLAN HISTORY

Urban Flood Risk Management in Ireland has historically been the remit of the Local Authorities. Under the Local Authority Act 1946 the role to enter and alter land in the incident of flood was their sole responsibility. The Commissioner of Public Works (Office of Public Works) role in relation to river management has evolved over time but the Arterial Drainage (Amendment) Acts of 1995, 2004 and 2010 changed the role forever - from land drainage to flood protection.

Prior to the founding of the state, the Office of Public Works (OPW) along with Local Authorities and Drainage Boards were involved in the design and construction of Drainage Districts under several different Drainage Acts. The purpose of these schemes was to improve the drainage of the land for agricultural use and not in terms of flood protection for people, although some urban works were undertaken incidental to these schemes. These schemes were generally constructed by the OPW or individual Drainage Boards set up for this purpose. The ongoing maintenance was carried out by the Local Authorities, the Drainage District boards or the OPW. The OPW had an overall inspection role of all of these schemes.

In 1945 the Arterial Drainage Act established the programme for construction of Arterial Drainage schemes. This act clearly defined the OPW as the body responsible for the construction of new Arterial Drainage schemes. Any schemes constructed under this act were to be maintained by the OPW. The inspection and maintenance of schemes constructed under the Acts listed below were to be maintained by the Local Authorities and in some cases incorporated into the new Arterial Drainage schemes.

- The Drainage and Navigation (Ireland) Acts, 1842 to 1857
- The Drainage and Improvement of Lands (Ireland) Acts, 1863 to 1892
- The Arterial Drainage Acts, 1925 and 1929
- The River Owenmore Drainage Act, 1926
- The Arterial Drainage (Minor Schemes) Act, 1928

The older drainages acts and their provisions outlined in relation to drainage of agriculture lands are still being applied today, though over time the funding for the Local Authorities to maintain Drainage Districts has been altered. Originally as part of the design process for the schemes, valuers walked the land and defined and mapped the land parcels that would benefit from the proposed drainage scheme. A rate was then calculated by the valuers and charged to the land owners on an annual basis. These

monies were collected by the local authorities and assisted in covering the cost for the ongoing maintenance of the schemes, as well as construction of the schemes.

In 1977 "Give Away Budget" abolished land rates and the source of funding for the maintenance of Drainage Districts not constructed by the OPW under the Arterial Drainage Act, *"Rates will be abolished from January next on all private and local authority houses, and on the residential portion of business houses, all secondary schools, bona fide community halls and farm outbuilding*", as quoted from the Fianna Fail Manifesto published in the Galway Advertiser (dated 1977).

During the 1980's and early 1990's a number of severe flood events hit a number of Irish urban centres including Kilkenny, Dublin and Clonmel to name but a few. The Local Authorities knowledge and understanding on carrying out works in the rivers had decreased with very limited funding being available to carry out these works. The OPW had carried on working in the rivers, by the requirement under the 1945 Act to maintain any scheme constructed by them and by completing the Monaghan Blackwater and Boyne Schemes, during this period. Hence when it came to identifying an organisation to review flooding in rivers it was felt that the OPW had the experience to expand their remit to cover this area.

In 1995 the original 1945 Arterial Act was amended with the Arterial Drainage (Amendment) Act 1995. Under this act the OPW's new role relating to Flood Risk Management was first introduced. However, the importance of the Local Authorities' role in flooding was not removed, rather better defined. The 1995 Act allowed the OPW, in partnership with Local Authorities, to carry out urban focused flood relief schemes - Kilkenny, Clonmel, Mallow and Fermoy, to name a few of the number of flood relief schemes constructed and funded by the OPW since 1995.

When the River Tolka flooded repeatedly in the 1990s and early 2000, a combination of different parts of flooding legalisation was used to deliver the project, as no single piece of legalisation could be used. Since the completion of the Catchment Flood Risk and Assessment Management Plan for the Tolka in 2002 there have been a number of key changes to the law and policy.

In 2004 the OPW were appointed as Lead Policy Agency for Flooding in Ireland. The roles of the OPW and Local Authorities together are critical in delivering effective flood risk management in Ireland. The EU Floods Directive of 2007 transposed into Irish law under Statutory Instrument 122 of 2010, requires an integrated catchment approach as applied on the Tolka.

Key requirements of the EU Floods Directive 2007 / SI 122 of 2010 are:

- Preliminary Flood Risk Assessment
- Production of Flood Maps
- Development of Flood Risk Management Plans

Other provisions include:

- Co-ordination with WFD implementation
- Trans-boundary co-operation (Northern Ireland)
- Public dissemination / engagement

Culminating in a Catchment-based Flood Risk Assessment and Management (CFRAM) whereby the following objectives are considered in detail:

- Assessing and mapping existing and potential future flood risk (including climate change)
- Identifying viable flood alleviation measures to define long-term, sustainable plan for flood risk management in catchments as a whole.

# 4 FLOODING HISTORY

## 4.1 Flooding Pre-Floodplain Management Works

Historically, the Tolka suffered a major flood in December 1954 which was the largest flood on record at the time that the GDSDS Tolka Study was commissioned.

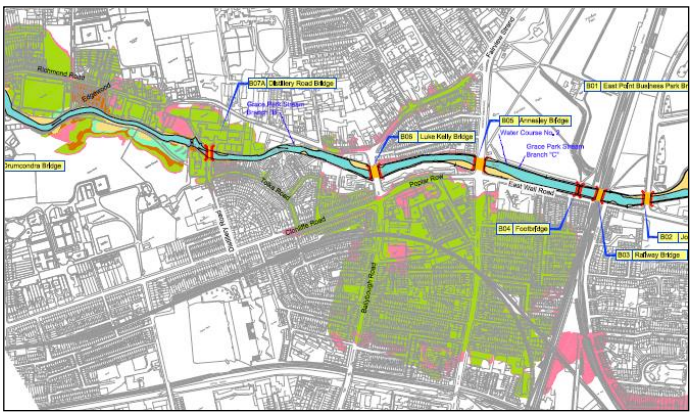


***Figure 2:*** *Historical Flood Extents*

The Tolka River has flooded on 20 occasions, see Table 2, with extensive impacts across the catchment area. Prior to this century in December 1954 and October 1880 there were two major flood events.

This century has since had three major flood events, with very different impacts on the catchment. The first event was in November 2000 followed shortly by November 2002 and October 2011.

As the 2002 study was underway, a flood of major proportions hit the Tolka on 15th November 2002. This flood resulted in peak river flows in Dublin City some 10% in excess of those estimated for 1954. At the same time, the flooding conditions in Dunboyne and Clonee were extraordinarily severe with large numbers of properties inundated.

***Table 2- Available Historical Flood Data***

| Ranking | Date | Estimated Flow at the outlet of the Tolka | Ranking | Date | Estimated Flow at the outlet of the Tolka |
|---|---|---|---|---|---|
| 1 | 14/15th Nov 2002[2] | 97m$^3$/sec | 11 | 20th September 1946[1] | 48 m$^3$/sec |
| 2 | 8th December 1954[1] | 85 m$^3$/sec | 12 | 23rd November 1898[1] | 45 m$^3$/sec |
| 3 | 6th Nov 2000 [2] | 76 m$^3$/sec | 13 | 12th November 1915[1] | 42 m$^3$/sec |
| 4 | 28th Oct 1880[1] | 71 m$^3$/sec | 14 | 3rd April 1909[1] | 37 m$^3$/sec |
| 5 | Winter 1965[2] | 59 m$^3$/sec | 15 | 2nd July 2009[2] | 30 m$^3$/sec |
| 6 | 24th October 2011[2] | 60 m$^3$/sec | 16 | 8th August 2008[2] | 30 m$^3$/sec |
| 7 | 26th August 1986[3] | 57 m$^3$/sec | 17 | 5th February 1946 | Minor Flood |
| 8 | 12th November 1901[1] | 57 m$^3$/sec | 18 | 3rd January 1948 | Minor Flood |
| 9 | 1st September 1931[1] | 54 m$^3$/sec | 19 | 19th December 1932 | Minor Flood |
| 10 | 1968[2] | 49 m$^3$/sec | 20 | 17th December 1916 | Minor Flood |

Notes:

[1]From 1955 Dublin Corporation Report on the 1954 Flood (estimate only)

[2]Recorded at Botanic Gardens station, The rating curve has been developed for flows up to 87 m$^3$/sec, flows in excess of this should be treated with caution.

[3]Recorded at Drumcondra station

## 4.2 Flooding Post-Floodplain Management Works

Subsequent to the extreme flooding event of 2002, the Tolka Flood Study report was commissioned as part of the Greater Dublin Strategic Drainage Study. Before the ink was dry on the final document the OPW, along with RPS Consulting Engineers, formerly M.C O'Sullivan & Co, were designing, planning and implementing the first part of the plan in conjunction with the flood-impacted Local Authorities. The works indentified as part of the study covered a number of different elements including channel improvements, erection of flood defence works (walls and embankments), provision of bypass channels, bridge upgrades, replacement of bridges and provision of flood attenuation storage, at different points along the river.

Due to the emergency response to the initial flood event by the OPW's Eastern Regional Arterial Staff the Local Authorities involved were aware of the OPW's capability. Following the detailed cost estimation of the Flood Alleviation Works, the Local Authorities and the OPW, who were funding the works, agreed that the OPW could carry out some of the works using their direct labour work force, as it was proven that the OPW could deliver at a much reduced cost.

Hence Dublin City Council, followed by Meath County Council and Fingal County Council, engaged the OPW's Eastern Regional Staff as their main contractor for the majority of the proposed works outlined in the plan.

***Figure 3:*** *Flood Alleviation Works*

Between 2002 and 2013 a co-ordinated approach to the works by the Local Authorities, OPW, Fisheries, DoEHLG, NRA, Developers and local landowners as stakeholders implemented nearly all of the recommendations in term of flood alleviation works outlined in the report. Not only did the OPW complete the works outlined in the report of 2002, they also completed a number of additional works added during the detailed design stage.

The works included approximately 11 Bridge replacements/upgrades with associated road improvement. 5km of earth embankment, 4.5km of channel improvements, 2km of new wall, 0.5km of culvert works, weir upgrades and all associated ancillary works. Also the drainage networks that were contributing to the flooding were modified by the addition of flap valves at pipe outlets to the river, pipe-work diversion works together with three new pumping stations and a GAA club changing facility.

### 4.3 Drumcondra Pumping Station and 2009 Flood Event

The construction of Drumcondra Storm Water Pumping Station marked the Final Phase of Flood Alleviation Works on the River Tolka, facilitated Urban Drainage Accommodation (pooling of surface water on Botanic Avenue) during high river levels in the Tolka. The pumping station is located on the west bank of the Tolka just upstream of Drumcondra Bridge.

Construction was complete by June 2009 resulting in a pumping station on the site of Rosmini Gaels Football Club. The three pumps have a maximum pumping rate of 800l/s via a flapped outlet/rising main to the Tolka River upstream of Drumcondra Bridge.

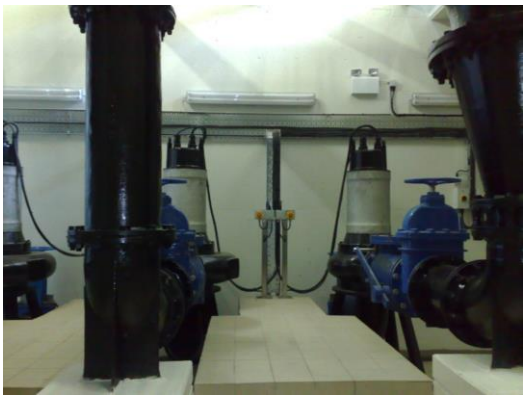

***Figure 4:*** *Pump Station*

The new pumping station proved its worth almost immediately after being commissioned, during a Pluvial Rainfall Event on 2nd July 2009 between 3-4am, when 3,000 $m^3$ of surface water was pumped directly to the River Tolka. It proved useful again during the extreme flooding event of October 2011. In both these instances dozens of houses and some business as well as Drumcondra Road (national primary route) and Botanic Avenue were saved from significant flooding. The pumping station has already paid for itself several times over.

## 5 THE PLANNING SYSTEM AND FLOOD RISK MANAGEMENT GUIDELINES

The Planning System and Flood Risk Management Guidelines for Planning Authorities, were published November 2009 by DoEHLG and OPW. One of the main objectives of these guidelines is to identify the following zones with regard to flooding:

- Flood Zone A – where the probability of flooding from rivers and the sea is highest (greater than 1% or 1 in 100 for river flooding or 0.5% or 1 in 200 for coastal flooding);

- Flood Zone B – where the probability of flooding from rivers and the sea is moderate (between 0.1% or 1 in 1000 and 1% or 1 in 100 for river flooding and between 0.1% or 1 in 1000 year and 0.5% or 1 in 200 for coastal flooding);

- Flood Zone C – where the probability of flooding from rivers and the sea is low (less than 0.1% or 1 in 1000 for both river and coastal flooding). Flood Zone C covers all areas of the plan which are not in zones A or B.

Within the 2002 Tolka Flood Study, Flood Zone A had been identified and extents mapped. However, Flood Zones B and C had not been identified. In 2010, RPS Consulting Engineers were appointed by Dublin City Council, acting as an agent for the OPW, to deliver services to provide 1:1,000 probability (0.1% annual exceedance probability, AEP) floodplain extents mapping for the River

Tolka. RPS's brief for this floodplain mapping project was to assess the 1:1,000 floodplain extents by hydraulic modelling using the proposed defences as modelled in the original Tolka Flood Study Infoworks RS Model, i.e. not using "as-constructed" information.

Originally the 2010 brief was to use existing survey/LiDAR data as used for the original Tolka Flood Study. The scope was changed by virtue of OPW making available updated LiDAR data (2009/2010) starting with Dublin City Council area, followed by Fingal County Council and eventually followed by Meath County Council area over the course of the flood mapping update study.

### 5.1 Flood Extents for 0.1% AEP

As the Tolka River is tidal up to Drumcondra bridge, within the Dublin City Council administration area, RPS modelled and presented a number of joint-probability analysis scenarios, comprising:

- 1 in 1000 fluvial, 1 in 2 tidal
- 1 in 100 fluvial, 1 in 200 tidal
- 1 in 25 fluvial, 1 in 1000 tidal
- 1 in 10 fluvial, 1 in 1000 tidal
- 1 in 5 fluvial, 1 in 1000 tidal
- 1 in 2 fluvial, 1 in 1000 tidal
- 1 in 2 fluvial, 1 in 200 tidal

Further to the review of the flood mapping in September 2010 by DCC and OPW, it was concluded that the 0.1% AEP fluvial coupled with the 50% AEP tidal event was the most appropriate to apply to Tolka River for the Dublin City area. This combination of fluvial and tidal events was found to produce the highest estuary levels, thus making it the critical design 0.1% AEP event.

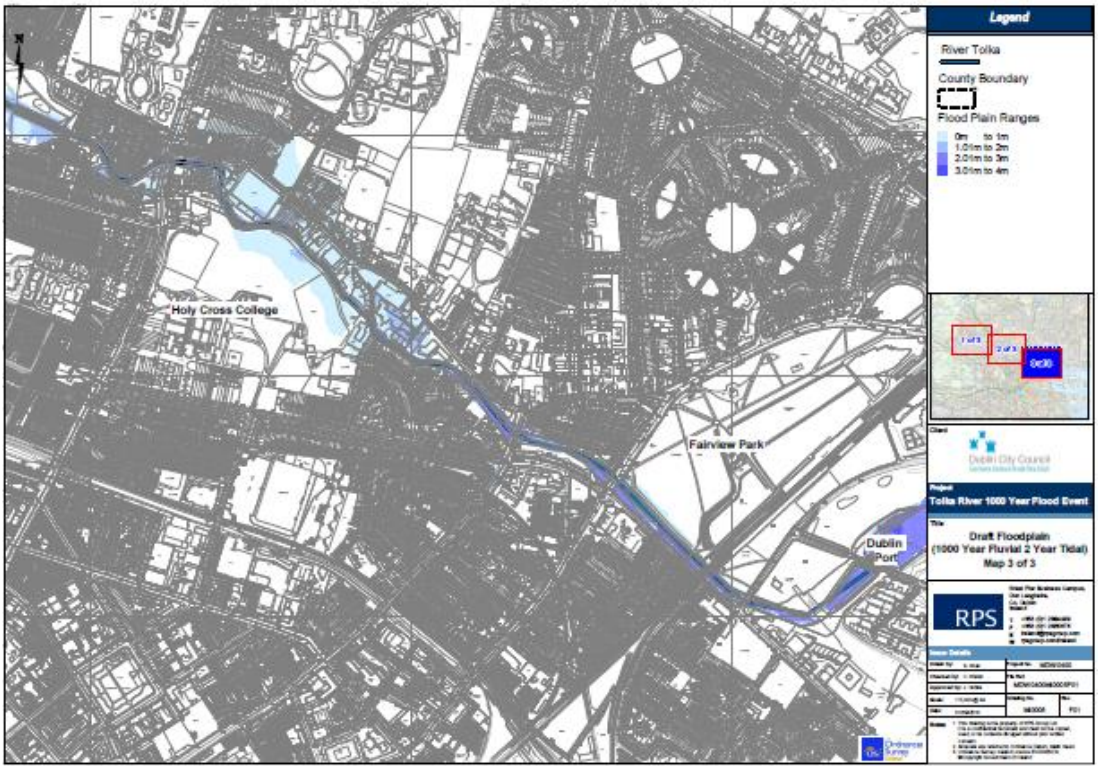


***Figure 5 - Flood Extents for 0.1% AEP – Dublin City Council (Tidal area)***

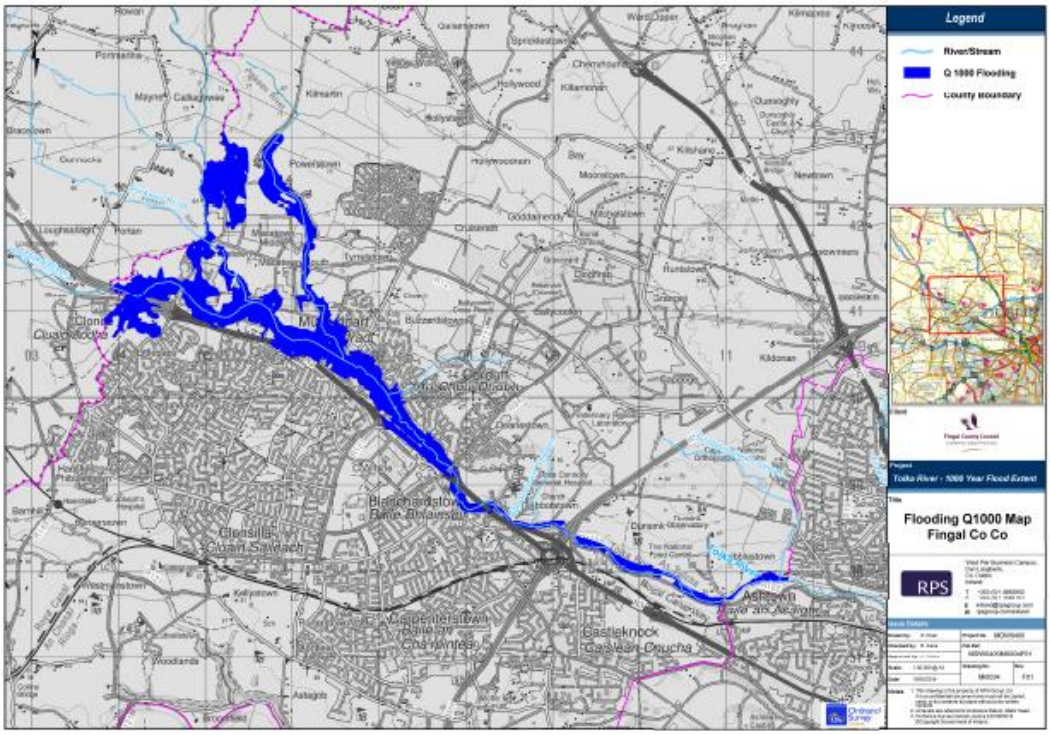


***Figure 6 – Flood Extents for 0.1% AEP – Fingal County Council***

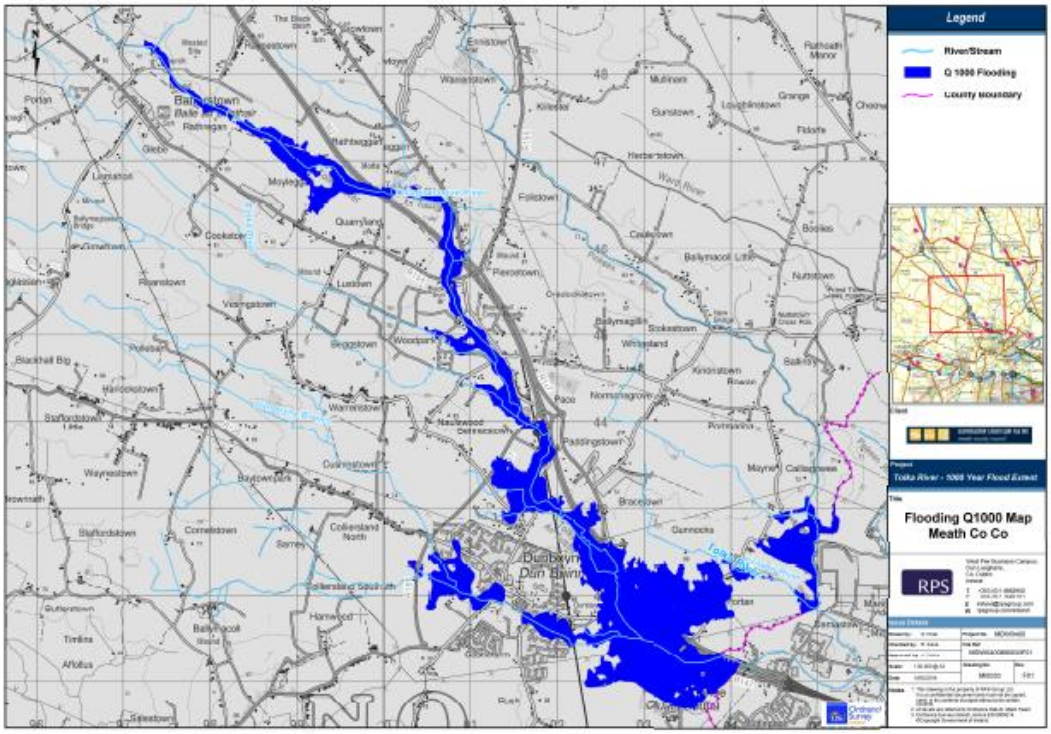


***Figure 7 - Flood Extents for 0.1% AEP– Meath County Council***

The 1 in 1,000 flood maps (0.1% AEP) are now being used by the three Local Authorities for land zoning in their Development plans under the DoEHLG/OPW Guidelines.

### 5.2 Digital Terrain Model

Some areas within the Tolka Catchment, particularly in the more rural parts, have been developed over the past decade. Figure 6 below shows the Meath /Fingal area of the Tolka Catchment whereby RPS carried out a comparison between the two LiDAR datasets used, showing a detailed difference layer and random points labelled with the differences between the two datasets.

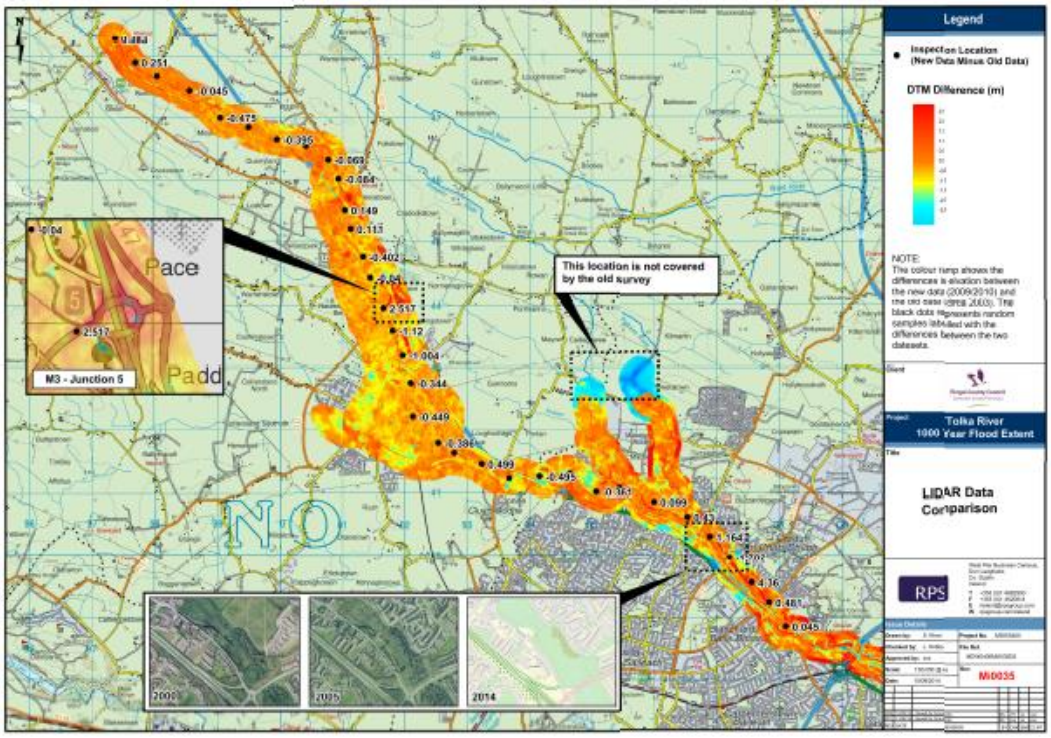


***Figure 8 – LiDAR Data Comparison 2002 vs 2010***

Examples are shown on the map indicating for example, the recent development at Castlecurragh/Mulhuddart and the new Railway Station / M3 Parkway, both areas that were once green fields (referencing OSi year 2000 Ortho-photography). The comparison of survey data pre and post development during the housing boom of the mid 2000s confirms DCC & OPW's suggestion that the use of the updated 2009/2010 LiDAR data would prove a worthwhile exercise.

## 6 FISHERIES ENVIRONMENT

The following measures were incorporated as part of the River Tolka Flood Alleviation Works:-

- Low flow channel created
- Boulders to create riffles and pools
- Small natural stone weirs
- Notches added to existing low weirs
- Removal of large disused weirs
- Fish passes

***Figure 9 Tolka Wildlife 2014***

An Irish Times article on Wednesday, September 28, 2011 noted that "fish surveys indicate the presence of juvenile wild Atlantic salmon in three river locations in the Glasnevin and Finglas areas. Adult fish are also being counted in the Glasnevin area." The Irish Times article also quoted Dr Ciarán Byrne, chief executive of Inland Fisheries Ireland, as

saying "the re-colonisation is no doubt linked to reduced pollution levels."

It was also acknowledged that the Tolka Flood Alleviation Works had no small part to play, particularly in the removal or modification of a significant number of man-made weirs to open up the river system to migratory fish. It was reported that after work on the Tolka was completed, adult sea trout immediately ran the system all the way upstream to its headwaters in Dunboyne, Co Meath, for the first time in at least 150 years.

## 7 FUNDING

The Tolka Study was originally part of the Greater Dublin Strategic Drainage Study and was funded by the DoEHLG, with Dublin City Council as the Lead Authority for the Study. The cost of implementing the Flood Alleviation Works was mainly funded by the OPW through the Local Authorities. The cost estimate for implementing the proposed scheme was €32 Million in 2004. The Study also recommended that an annual budget for maintenance and monitoring be set up and provided to the order of €100,000 per annum.

The cost of implementing the scheme for alleviation of flood risk to existing developments was estimated on a whole life cost basis, inclusive of construction works, planning, overheads and annual maintenance / management costs discounted to Net Present Value. Cost estimates were based on classical procurement and implementation methods. Implementation required a co-ordinated approach to the works by Local Authorities, OPW, Fisheries, DoEHLG, NRA, Developers and local landowners as stakeholders.

The Implementation Cost was made up of the following:

- The construction cost of the various works, based on 2004 estimated costs. These costs took account of construction conditions including assumed geotechnical/ground conditions, a degree of interface with existing services, anticipated ancillary works to accommodate landowners and other stakeholders' requirements.
- Detailed site investigations at design stage including geotechnical and geological investigation, services investigations, environmental investigation including archaeological and ecological conditions and detailed investigation of river-side structures, particularly structures to be retained. (walls and banks)
- Environmental mitigation and reinstatement work including landscaping, river restoration, fisheries accommodation and other requirements of statutory process and consultation.
- Overhead costs including land acquisition, design costs, technical supervision costs and other management charges.

Provisional sums and contingencies for costs not fully defined were included. In particular, these related to the cost of modifications to existing piped drainage systems in low-lying areas to prevent secondary flooding.

Allowance was made for certain ongoing costs which would be incurred by the relevant authorities in the operation and maintenance of the scheme including river channel maintenance and routine inspections of structures, embankments etc. River catchment management costs including co-ordination of the maintenance function, co-ordinated approach to development planning, maintenance

and oversight of the flood warning/monitoring telemetry system and communications strategy for the relevant bodies and for the public.

The total spend up to year end 2013 is €19,681,214 by the OPW with nearly all the works completed.

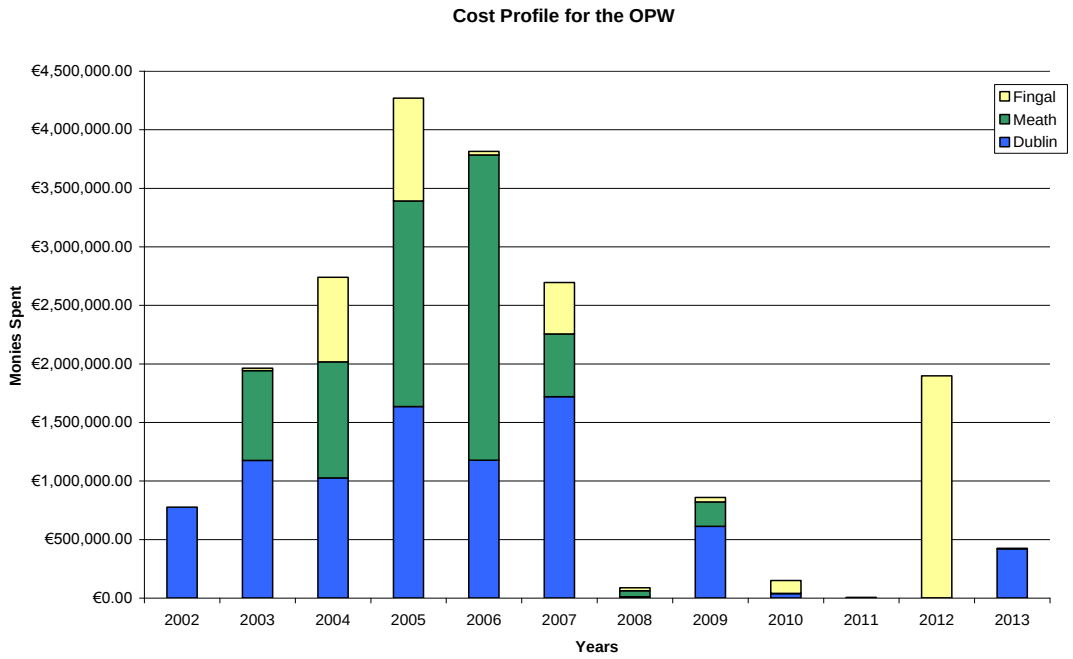


***Figure 10 - OPW's Cost Distribution by County***

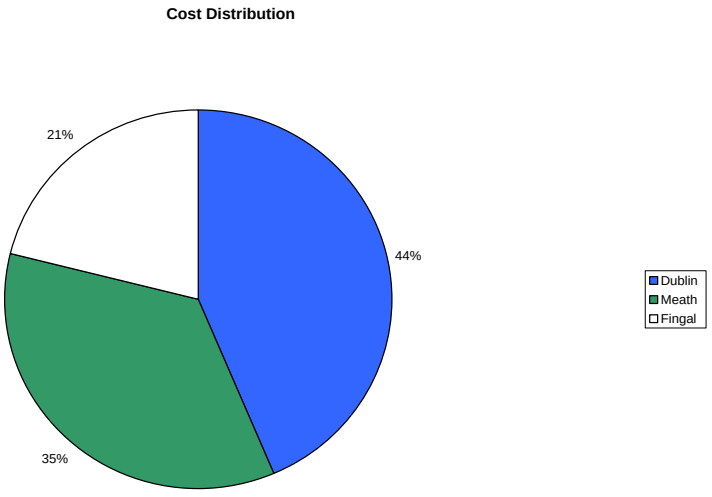


***Figure 11 - OPW's Cost Profile by Year on Flood Alleviation Works on the Tolka***

## 8 SUMMARY

The River Tolka Flooding Study identified that substantial areas of urban development in the study area were at risk of repeat flooding from the River Tolka.

The report outlined the works required to reduce this risk to less than 1% annual risk. These works comprise the River Tolka Flood Alleviation Scheme carried out between 2003 – 2008 (river works). In addition, modifications to the urban drainage system and pumping stations were identified as necessary and completed by 2010.

The cost of implementing the scheme was estimated at € 32 million. Utilising OPW direct labour for the construction of flood works on the Tolka halved the out-turn cost of construction.

To date the River Tolka Flood Alleviation Scheme has performed well and, in addition to the primary technical objectives being achieved (ie to ameliorate against flood risk), it has also met social, economic and environmental objectives that are now being incorporated into the National CFRAM Programme's multi-criteria assessment process for flood risk management plans.

The answer to the question posed at the beginning of this paper is a resounding 'yes' - the objectives have been achieved, the plan has been implemented successfully, and the works are performing effectively.

## 9 REFERENCES

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