



**Waterman Moylan**  
Engineering Consultants



## **Adamstown Strategic Development Zone Surface Water Drainage Engineering Assessment Report**

Consolidated Review of Strategic Surface Water Drainage  
via the Tobermaclugg Stream and Backstown Stream

**December 2017**

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## Quality Assurance – Approval Status

This document has been prepared and checked in accordance with  
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## 1. Overview

This report has been prepared by **Waterman Moylan Engineering Consultants Limited** to consolidate all previous surface water reports (from 2005 - 2010) prepared by **PH McCarthy Consulting Engineers (Subsequently WYG)** for the Upgrading of **Tobermaclugg Stream** to drain the bulk (approximately 85%) of the **Adamstown Strategic Development Zone (ASDZ)** Surface Water Catchment (200 ha) and the subsequent remedial works. It also takes into account the updated **2014 SDCC Adamstown SDZ Planning Scheme** to ensure overall compliance regarding surface water going forward.

PH McCarthy Consulting Engineers (PHMcC) had been appointed to carry out an assessment of the proposed amelioration of the **Tobermaclugg Stream**, as an element of the development of the ASDZ Lands in South Lucan.

There were approximately 200 hectares of formerly agricultural lands set aside for development within the ASDZ, which will increase the volume and rate of surface water runoff incrementally until it is completely developed. The first phase of construction commenced in 2004 through Planning Permission **SDZ 04/001A**. Following a series of subsequent permissions, approximately 1395 units of the initial 10 000 units (subsequently revised down to 7 010 - 8 905 units – see pg 10 ASDZ 2014 Planning Scheme), with the associated infrastructure, were completed and occupied in accordance with the ASDZ Planning Scheme, by means of a series of phased construction, up until around 2009. Due to the onset of the recession in late 2008 (in full swing by mid-2009), development within the ASDZ practically ground to a halt until around 2016.

The Adamstown SDZ area is naturally subdivided into three **Surface Water Drainage** sub-catchments as follows: -

- i) **Tobermaclugg Stream** catchment, which covers most of the ASDZ, (65%) drains to the north.
- ii) **North East** (Griffeen Tributary) catchment consists of approximately 20% of the ASDZ and will mostly be redirected to the surface water outfall via the Tobermaclugg by agreement with SDCC due to issues with the receiving system to the north east.
- iii) **South East** (Griffeen Tributary) - This catchment consists of approximately 15% of the ASDZ.

Given the scale and significance of the ASDZ, the development and its surrounding surface water catchments have been fully analysed and a fully engineered system designed and constructed to manage and control the storm and development flows to reduce flood occurrences and protect against pollution of the bio-systems of the watercourses. The design and construction to date was developed through multiple reports (dating back to the inception of the SDZ), models and subsequently construction contracts during the period 2003 to 2010.

This Report will demonstrate that the designed and implemented system meets the requirements of the Adamstown SDZ Planning Schemes and Greater Dublin Drainage Strategies to convey surface water, prevent flooding and protect the environment, in accordance with the following criteria:-

- **No surcharge in 2 years Average Recurrence Interval (ARI) rainfall event**
- **No flooding in a 30-year ARI rainfall event within the ASDZ**
- **Only localised ponding of the Lucan Golf Course would occur under 1 : 100 year ARI return storms and above. However, this will occur for a short duration only and the golf course is unlikely to be open under such extreme events**
- **No flooding of Tubber Lane Road in a 100 year ARI rainfall event**
- **No flooding of the proposed Tobermaclugg Pumping Station in a 1 000 year rainfall event**
- **A basic continuous flow of 100ℓ/s in the Tobermaclugg Stream through the ASDZ and downstream of the old confluence point**
- **Continuous flow in the salmonid Tobermaclugg/Backstown Stream in the Golf Course**
- **The stormwater culvert through the Lucan Golf Course serves as the emergency outfall for the Tobermaclugg Foul Pumping Station**
- **To protect the streams from the risk of pollution from run-off of paved areas, (by the initial rainfall in any storm washing oils, grease, grits and organics into the system) it was agreed that Downstream Defenders, located at strategic locations within the SDZ be installed to remove suspended solids, whilst performing as a Class 2 hydrocarbon separator.**
- **Secondary treatment has been provided by means of a reed planted 5000m<sup>3</sup> attenuation pond next to the Millstream Road**

Therefore in summary the following has been implemented as at 2010 for the Tobermaclugg Stream (See overall ASDZ Surface Water Drawing SK121):-

Reach	Culvert Size Installed as at 2010	
	Length (m)	Description
Reach 1 (Through ASDZ)	181	1 № 1500 mm ø.
	657	Temporary channel/overflow open
	33	1 № 1500 mm ø.
	301	1 № 1200 mm ø
	388	1 № 1500 mm ø
	495	1 № 2100mm ø
	<b>2055</b>	
Reach 2 (Lucan GC)	878	1 № 2400 mm ø
	44	Open channel through Pond
	29	Twin 2.1m box culverts
	76	2.9m x 1.7m rect. open channel
	31	3.6m x 1.2m rect. open channel
	<b>1058</b>	

**Culvert size Summary Installed as at 2010**

Therefore it can be noted that the external Surface Water Drainage, into which the ASDZ drains, has been completed in accordance with the SDCC's Planning Scheme and GSDSDS, which includes the secondary treatment with the provision of a 5000m<sup>3</sup> reed planted attenuation point next to the Millstream Road.

2.1/2.4m ø pipes have been installed (through Tobermaclugg Park) passed the Tobermaclugg Foul PS and through the Lucan Golf course to cater for the surface water discharge requirements of the ASDZ Tobermaclugg and North East catchments along with a series of surface water pipes within the SDZ to accommodate the surface water for the fully post development ASDZ. All that remains is for the remaining undeveloped areas within the SDZ to be progressed based on the agreed surface water design strategy and to complete the detail design to connect into the existing installed surface water pipes.



## 2. Adamstown SDZ – Extracts from SDCC 2014 Planning Scheme

At the onset of the preplanning and development of the Adamstown Strategic Development Zone (ASDZ), numerous meetings took place between the engineers, planners, designers and the engineering and planning departments within South Dublin County Council prior to the approval of the first draft of the Planning SDZ document. From these meetings and throughout the development of the preliminary assessments, and then subsequent designs, the Planning Documents and Guidelines were updated to reflect the strategy in dealing with the surface water and the **Tobermaclugg Stream**, as well as other engineering considerations for the ASDZ.

As can be seen in previous SDCC documents, the area was zoned “To provide for new residential communities in accordance with approved Action Area Plans” when SDCC adopted the South Dublin County Development Plan in 1998.

In summary, the following process took place to arrive at the current 2014 ASDZ Planning Scheme: -

- i) *In December 2002, a Draft Planning Scheme was prepared and submitted to the Elected Members of South Dublin County Council. An Bord Pleanála held an oral hearing in respect of the Draft Planning Scheme during July 2003. The Board approved the Planning Scheme, subject to 26 further modifications, on 25 September 2003.*
- ii) *In October 2013 South Dublin County Council, being the specified Development Agency for the Adamstown SDZ and the relevant Planning Authority, submitted 49 proposed amendments to the Adamstown SDZ Planning Scheme, 2003 (as amended) to the Elected Members of South Dublin County Council. An Environmental Report, under the provisions of the SEA regulations, was prepared in respect of the Scheme. Following a screening exercise, the Planning Authority determined that an Appropriate Assessment was not required in respect of the Adamstown SDZ Planning Scheme 2003 and the proposed amendments.*
- iii) *On 10<sup>th</sup> February 2014, South Dublin County Council decided by resolution, to amend the Adamstown Strategic Development Zone (ASDZ) Planning Scheme, 2003, subject to variations and modifications as detailed in the addendum document. A*

*motion to amend a phasing requirement was also proposed and passed by the Elected Members.*

*Following an Oral Hearing, An Bord Pleanála approved the amendments to the Planning Scheme, subject to 11 further modifications on the 2<sup>nd</sup> December 2014. The Adamstown Strategic Development Zone Planning Scheme Document (Dated Dec 2014) comprises of the consolidated Planning Scheme and incorporates all changes, variations and modifications to date.*

Below are extracts from the current Dec 2014 ASDZ Planning documents in relation to the Tobermaclugg Stream, for ease of reference. One particular aspect, as reflected in "2.5.7" below, is the agreement with SDCC to divert the flow from the North East Griffeen Catchment to the Tobermaclugg catchment in the North West of the site, due to challenges and constraints faced through the existing development to the north east of the ASDZ.

## **2.1 EXTRACT FROM ADAMSTOWN STRATEGIC DEVELOPMENT ZONE SOUTH DUBLIN COUNTY COUNCIL DECEMBER 2014 DEVELOPMENT PLANNING GUIDELINES**

*Adamstown is subdivided into three surface water drainage sub-catchment as follows:-*

### **Tobermaclugg**

*2.5.5 Most of the SDZ (65%) is drained to a large surface water outfall and attenuation pond at Tobermaclugg Stream. The Tobermaclugg Stream is joined by the Backstown Stream on leaving the SDZ and continues along Tubber Lane and under the N4 via a culvert before discharging to the River Liffey in the vicinity of Lucan Village.*

*2.5.6 In order to cater for up to a 100-year storm, the stream capacity of Tobermaclugg was supplemented by the construction of a 2400mm diameter surface water pipeline and attenuation pond. Dry weather and normal flows will continue to discharge into Tobermaclugg Stream.*

### **North East Griffeen Tributary**

*2.5.7 This catchment consists of approximately 20% of the SDZ and is drained to the surface water outfall and attenuation pond at Tobermaclugg.*

*2.5.8 Attenuation has been achieved by using underground storage in the form of a combination of precast concrete tanks and oversized pipes in conjunction with flow control devices.*

### **South East Griffeen Tributary**

*2.5.9 This catchment consists of approximately 15% of the SDZ. A section of this area drains to the Griffeen River via oversized pipes into precast attenuation tanks. On leaving Adamstown, it drains to an existing 450mm diameter pipe under the Newcastle Road before continuing eastwards and discharging to the main channel of the Griffeen River.*

2.5.10 The remainder of the South-East Catchment comprises of a gravity-fed system via oversized pipes and precast concrete attenuation tanks with flow control devices, discharging to the Griffeen River.

Below is a map extracted from the current Dec 2014 ASDZ Planning documents in relation to the following:-

- i) the three Surface Water Catchment Areas and
- ii) the Tobermaclugg Stream and its planned route through the ASDZ.

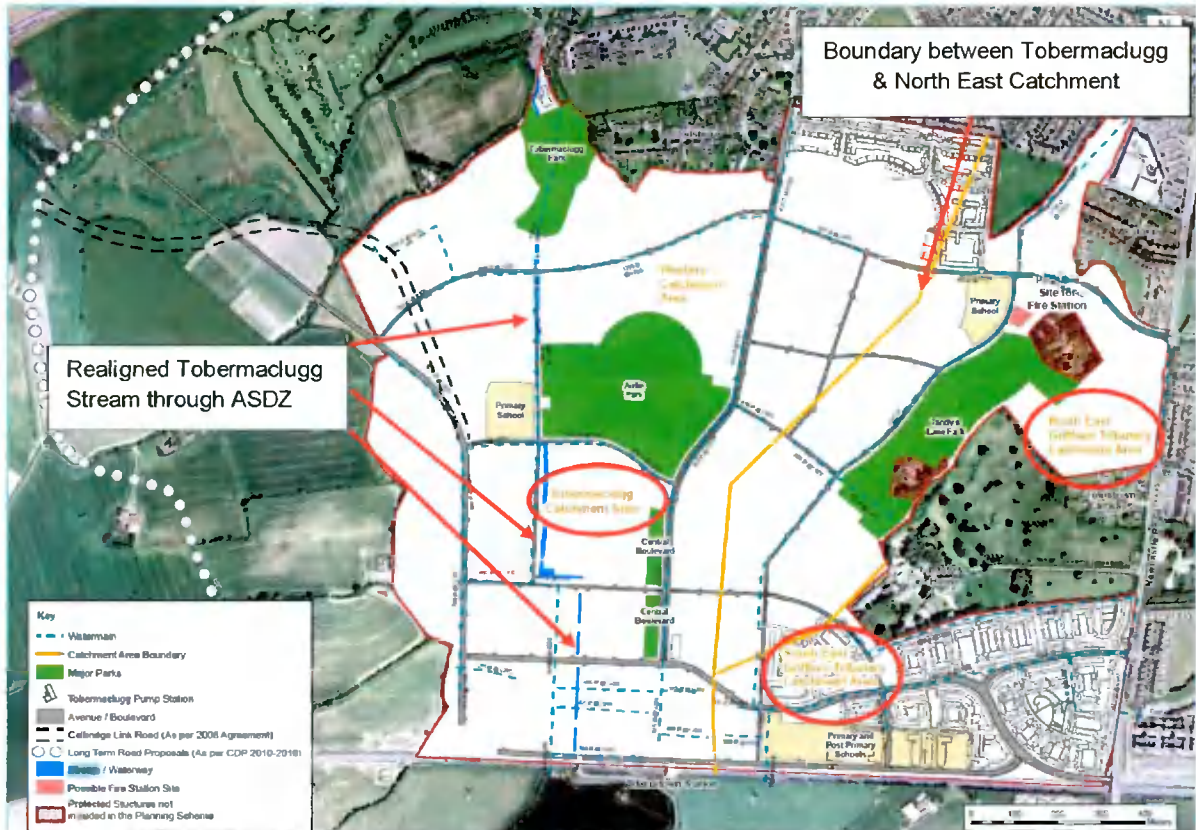


Fig x.1 Extract from 2014 SDCC ASDZ Planning Document (Fig 2.26 Main Surface Water Drainage Network)

## 2.2 EXTRACT FROM - 2014 ADAMSTOWN SDZ PLANNING DOCUMENT – REGARDING PHASE 3

With reference to the SDCC planning documents, the following paragraph has been extracted from the table reflecting the various aspects of the infrastructure that must be completed relating to Phase 3 of the development of the ASDZ.

*“Works to upgrade Tobermaclugg Stream between the SDZ lands and the N4 to include upgrading the Tubber Lane (Road) surface water drain, regrading sections of the channel and enhancing the capacity of the N4 culvert (not illustrated). (Complete)”*

### 3. Environmental Issues

#### 3.1 POLLUTION CONTROL

There is a risk of pollution from run-off of paved areas. This is caused primarily by the initial rainfall in any storm washing oils, grease, grits and organics into the system.

To protect the watercourses in the area, appropriately sized "Storm King" type Downstream Defenders will be installed at strategic locations on the stormwater sewers within the ASDZ.

- i) These units will ensure the water quality being discharged into the pipe network leading to the Stream and protect against the 'first flush' occurrence of a rainfall event. The "Downstream Defender" is an advanced hydrodynamic separator designed to remove sediment, floatables & associated pollutants from storm water.
- ii) This device meets the separation requirements for a class 2 oil interceptor, without the alarms, and also removes material suspended within the water column that will settle out. The device is constructed into a concrete manhole and is made from co-polymer polypropylene, which will not corrode and has no moving parts. The "Downstream Defender" is positioned to allow for easy access and is maintained using a simple gully sucker to remove the oils and sediments by means of the access points provided.

Further secondary protection is provided by the 5000m<sup>3</sup> attenuation pond constructed downstream of the Lucan Golf Course planted with reeds, as specified by **Vesi Environmental Consultant**. This will protect both the lower reaches off Tobermaclugg / Backstown Stream and the River Liffey.

#### 3.2 FISHERIES

The Tobermaclugg / Backstown Stream, downstream of the confluence, is designated salmonoid.

The Millstream Road and Tubber Lane box culverts have been modelled and installed to include partial burying to 300mm below the existing stream bed and reinstatement of the bed to the requirements of the Eastern Regional Fisheries Board (ERFB).

### **3.3 ARTERIAL DRAINAGE ACT 1945 (SECTION 50)**

Under the Arterial Drainage Act of 1945 (Section 50), works altering any bridge or culvert affecting the hydraulics of a watercourse received approval from the Office of Public Works (OPW) prior to commencement.

### **3.4 VEGETATION**

The channel and surrounding banks upstream of the Millstream culvert are vegetated with medium dense brush and small trees that border the streambed. Vegetation sporadically overtops the channel and can create resistance to the flow of water in times of high water. The Lucan Golf Course maintains the channel edges through the golf course.

Over grown vegetation was found between Millstream culvert and the N4 culvert prior to the upgrade works and was cut back under the supervision of SDCC. This growth was limited to the banks of the stream but overhangs the main channel and would create a high resistance to flow in times of high water. This would be under the control of SDCC in relation to maintenance and can be assumed that periodical maintenance works has been and will be carried out to clear the upstream entrance to the N4 culvert to clear debris.

This area was walked with a representative from SDCC Parks Division and agreement was reached in relation to the development for the 5000m<sup>3</sup> attenuation pond with its suitable landscaping plan, which was incorporated as part of the scheme. An ecological survey of this area was undertaken in advance of the Part 8 Planning Process.

## 4. Adamstown SDZ – Hydraulic Model Methodology & Analysis

### 4.1 STUDY AREA DESCRIPTION

The Adamstown Strategic Development Zone (ASDZ) lands, approximately 200 ha in area, are located 13km west of Dublin and 1.5 km south of Lucan Village. The ASDZ is bounded by the Dublin - Kildare railway line to the south, the R120 (Newcastle/Lock Rd or more recently renamed Adamstown Road) to the east, the existing development of Dodsborough and the N4 to the north and agricultural lands to the west. (See Figure A7 below)



Fig A7 ASDZ Location Map

## 4.2 ASDZ SURFACE WATER CATCHMENTS

The ASDZ is split into three surface water sub catchments, namely

- i) the Tobermaclugg Catchment,
- ii) the North-East Catchment and
- iii) the South-East Catchment

Of the 200 hectares of ASDZ lands, approximately 140 ha naturally drained to the **Tobermaclugg Stream Catchment**. (See in Fig B below). The remaining 60 ha comprises of two portions that naturally drained to the **South-East & North-East Catchments**, initially via the existing ditches and then surface water sewer network, and ultimately to the Griffeen River. The **Backstown Catchment** is outside of the ASDZ and located to the west & north west of the ASDZ as can be seen below, but was included in the study area due to its influence on the flows, as it converges with the Tobermaclugg Stream prior to its combined flow discharge to the River Liffey.

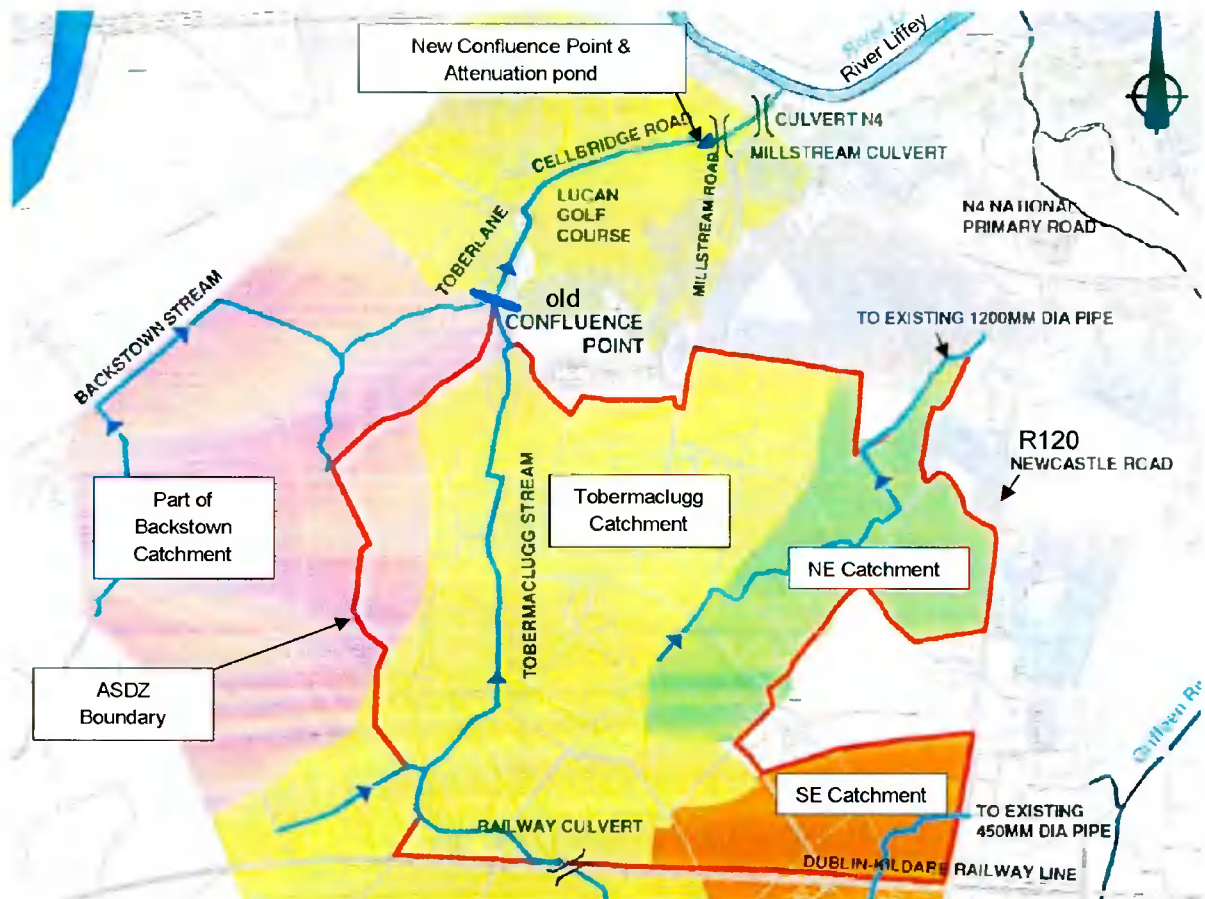


Fig B. Extract from PHMcC May 2005 Report (reduced Backstown Catchment)

The catchments are described further below in **Sections 4.2.1 – 4.2.3**. The main focus of this report is the **Tobermaclugg/Backstown Catchments** since it addresses 85% of the ASDZ. But it is worth noting that the **South East Catchment** (the remaining 15%) has almost been completely developed except for its western most portion that forms the earmarked **Leisure Centre** and a small proportion that extends into the proposed **Town Centre** (See Fig C below). In this catchment attenuation tanks, hydro brakes and “Downstream Defenders” have been provided at the agreed discharge rate. The attenuation constructed under the “All-Weather” pitch provides the capacity for the remaining area still to be developed.

#### 4.2.1 Tobermaclugg Catchment

The Tobermaclugg Stream catchment consisted of the land to the west of the South-East and North-East Catchment and to the East of the Backstown Catchment, which drains to the River Liffey in a northerly direction. It has a total catchment area of approximately 486 hectares, which extends south of the railway line as can be seen in **Figure 1.0** below.



The Backstown Stream converges with the Tobernaclugg Stream at Tubber Lane Road to the north of the ASDZ, before its combined flow discharges to the River Liffey in the north.

#### 4.2.2 South-East Catchment

The South-East catchment consisted of the lands south of Finnstown House Hotel. It is bounded to the south by the Grand Canal, to the east by the R120 Adamstown Road (formally referred to as the Newcastle/Lock Road) and to the west by the Western Sub-catchment and has an approximate area of 66 hectares.



Fig C. ASDZ South East Catchment (as at Google Image 2017)

At the time of pre-commencement of the ASDZ there was no storm water (piped) drainage system. This catchment drained into an existing stream (ditch system) within the catchment, which ultimately discharged to the Griffeen river, through an existing 450mm  $\varnothing$  pipe under the R120 (Newcastle/Lock Road) – See Fig B above. This catchment includes about 30 hectares of ASDZ lands to be developed. As of 2017, the full extent of this catchment has been developed and occupied, bar south western corner. – See Fig C above.

#### 4.2.3 North-East Catchment

The North-East sub-catchment consists of the lands immediately west and north of the Finnstown House Hotel and has an approximate area of 53 hectares. It is bounded to the east by the R120 (Newcastle/Lock Road), to the north by existing development and to the west by the Tobernaclugg-(and Backstown) Stream sub-catchment.



Fig D. Diversion of North East Catchment to Tobermaclugg Catchment

At the time of pre-commencement of the ASDZ there was no storm water piped drainage system within the lands. The North-East sub-catchment discharged into an existing stream (ditch network) within the catchment. This area originally discharged to an existing 1200mm  $\varnothing$  surface water pipe located to the rear (west) of the Supevalu (former Superquinn) shopping centre to the north. (See Fig B above and Fig D below) Some 29 hectares of the 53 hectares are within the ASDZ lands. However it was confirmed by SDCC that the surface water 1200 $\varnothing$  sewer in question has still not been taken in charge.

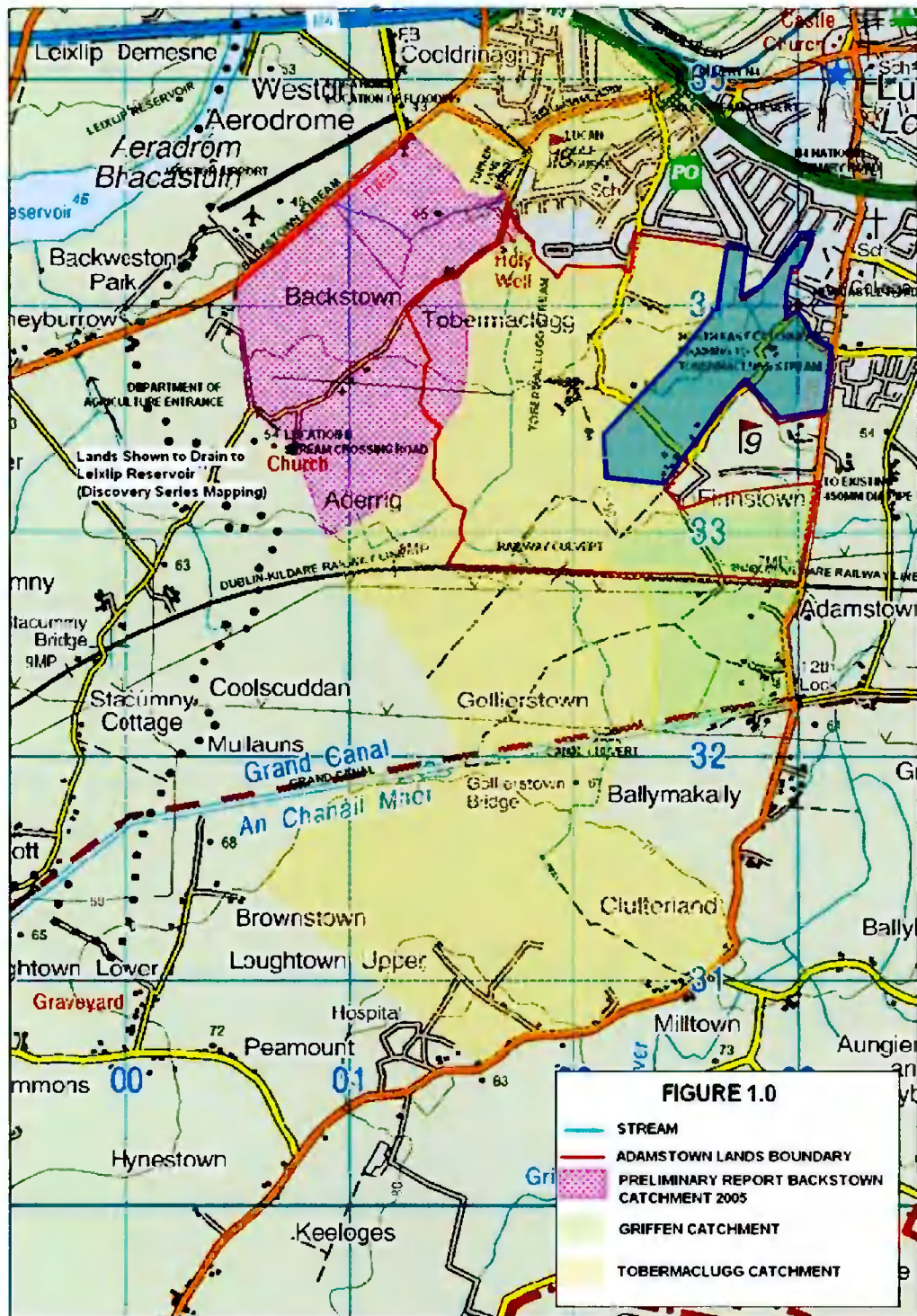
During 2006/7 Loop Road 1 (Adamstown Park) and Adamstown Drive were constructed along with the associated surface water drainage (Following the approval of the SDZ 05A/2 for the Paddocks, SDZ 06A/5 for the Strategic Roads and SDZ 07A/0012 for part of the Somerton Development Area), which intercepted some of the flows and diverted them to the Tobermaclugg outfall surface water system, as reflected above. The

remaining network of ditches still services the surface water run-off from Finnstown House Hotel, Finnstown Fairways (residential estate) and Somerton & St Helens houses.

#### **4.3 INITIAL 2005 CATCHMENT MODEL (TOBERMACLUUGG/BACKSTOWN)**

An *Infoworks CS* strategic hydraulic model of the Tobermaclugg/Backstown catchments was first developed in 2005 in accordance with "WaPUG code of practice", **Greater Dublin Strategic Drainage Study** (GDSDS) & best international practice. Prior to that, assessments were carried out to give guidance in the preparation of the areas 2003 SDZ Planning Scheme documents. Pre & post developed scenarios up to 2031 were initially simulated to estimate the design storm (**30yr ARI & 100 yr ARI**) and associated runoff. The catchment extents were based on contours, OS mapping & aerial photography. The extent of the **initial** catchments (Tobermaclugg Stream-Backstown Stream) modelled, and the location of flooding, are shown in **Figure 1.0** below along with the North East Catchment.

- Greater Dublin Strategic Study (GDSDS) Regional Drainage Policies require a 10% increase in rainfall intensity for climate change.
- Office of Public Works (OPW) Climate Change Requirements +20% when sizing the culverts under Millstream Road and Tubber Lane Road (See Section 50 Reports)



#### 4.3.1 Pre-Development of ASDZ Model Construction

The initial hydraulic model in accordance with the “WaPUG Code of Practice” comprised of the following:

- i) the full extent of the Tobermaclugg Stream catchment
- ii) the full extent of the Backstown Stream Catchment (However this was subsequently determined to have been under calculated, in error). *The correct figures were included in the 2009 reassessment.*
- iii) The housing developments draining into the stream at the time, based upon sewer records prepared by South Dublin County Council.
- iv) relevant information gleaned from the available contour plans, OS mapping and aerial photography.

Refer to the **May 2005 Report** for network schematics of the *InfoWorks* CS model. This model was updated and assessed when adjustments were made in **2006/7** and again in **2008** before the construction of the culverts to the north of the ASDZ and extents of **Reach 2** from just north of the ASDZ to the River Liffey.

A topographical survey was carried out on the streams and hydraulic structures, taking cross-sections at various locations on both the Tobermaclugg & Backstown Streams and the tributary to the Griffeen River, assessing details on the existing pipes, culverts, bridges, road crossings etc.

Four major culverts were noted along the Tobermaclugg/Backstown Streams until the discharge point into the River Liffey, some of which have been upgraded since the initial assessment. (The location of these **four major culverts** are noted on Fig 2.0 below)

- i) The first culvert crossing under the Grand Canal. Assumptions were made regarding the details of this culvert, due to lack of information available from the OPW and difficulties occurring accessing the culvert. It was then assumed, for the purpose of the study, that the flow through the culvert under the Grand Canal discharges freely.
- ii) The arched culvert under the railway line with dimensions of 0.75m x 0.90m. (Upgraded by CIE)
- iii) The arch culvert under the Millstream Road with dimensions of 2.86m x 1.64m (Upgraded to twin 2.1m box culverts, partly buried to approx. 300mm in 2008/9).
- iv) The culvert under the N4 - approximately rectangular in shape with upstream dimension of 1.7m x 2.0m traversing 78m with an approximate 30° bend left after approximately 58m from the inlet. The culvert then widens to accommodate the original stone arch structure 4m wide x 2m high, approximately 15m long. The Stone arch flows to a 3.6m wide x 2m high concrete box culvert approximately 15m long with a faced on the downstream culvert outlet replicating the stone arch structure.

### 4.3.2 System Analysis

As can be seen in the 2005/2008 Reports (aspects extracted below), the simulation model was run with a number of storms of various durations (30, 60, 90, 120, 240, 360, 480, 540, 720, 1440, 2160 and 2880 min) and return periods (1, 2, 5, 10, 30, 50, 100 and 200 years) to determine the critical duration storm. In line with the Greater Dublin Strategic Drainage Study (GDSDS), an allowance for the effect off climate change over the next 30 to 50 years was also included, which equates to **10% extra rainfall** on the catchment.

The **540 minutes duration with a winter profile storm** was established as the critical storm for the Tobermaclugg catchment. For the purpose of this study the critical storm is defined as the storm which results in the highest predicted peak flow **at the confluence point** of the Tobermaclugg and Backstown streams.

Table 4.1 below shows the predicted peak flows at confluence point of the Tobermaclugg and Backstown streams for various duration & return periods, including the **540 min critical duration**.

№	Rainfall Duration (min)	Predicted Peak flow (m <sup>3</sup> /s)							
		1yr	2yr	5yr	10yr	30yr	50yr	100yr	200yr
1	30	0.341	0.454	0.596	0.716	0.954	1.102	1.317	1.550
2	60	0.471	0.616	0.812	1.002	1.348	1.526	1.803	2.135
3	90	0.559	0.737	0.981	1.194	1.574	1.786	2.121	2.510
4	120	0.625	0.811	1.103	1.330	1.747	1.987	2.357	2.788
5	240	0.774	1.004	1.320	1.578	2.090	2.369	2.792	3.252
6	360	0.821	1.069	1.392	1.662	2.196	2.196	2.885	3.356
7	480	0.829	1.076	1.402	1.677	2.216	2.505	2.891	3.360
8	<b>540</b>	<b>0.831</b>	<b>1.087</b>	<b>1.417</b>	<b>1.696</b>	<b>2.241</b>	<b>2.529</b>	<b>2.911</b>	<b>3.385</b>
9	720	0.820	1.058	1.386	1.663	2.206	2.489	2.852	3.308
10	1440	0.714	0.906	1.191	1.452	1.963	2.239	2.565	2.935
11	2160	0.618	0.778	1.016	1.241	1.699	1.957	2.321	2.621
12	2880	0.550	0.687	0.893	1.086	1.488	1.721	2.081	2.400

Table 4.1 – Predicted peak flows (as extracted from the 2005 Report)

The model predicted flooding at various locations

- i) within the predeveloped ASDZ catchment,
- ii) in the Lucan Golf Course,
- iii) the old confluence point of the Tobermaclugg & Backstown streams and
- iv) at the railway culvert.

Flooding was known to occur at the above locations on a regular basis prior to the simulation assessment.

Table 4.2 below summarises the peak flow at four identified locations for the 30 year ARI and 100 year ARI storm events, which includes the Free Discharge point assumed at the Grand Canal.

Location	30 Year ARI Peak Flow (m <sup>3</sup> / s)	100 Year ARI Peak Flow (m <sup>3</sup> / s)
Flow from South of Grand Canal (Free Discharge)	1.76	2.62
Culvert Under Railway	1.28	1.28
Culvert Under Millstream	2.53	2.94
Culvert Under N4	2.63	3.07

Table 4.2 – Predicted peak flows at Culvert

Figures 4.1 & 4.2 within the 2005/2008 Reports demonstrate the predicted hydrographs for the existing Tobermaclugg-Backstown catchment for the 30 year and 100 year ARI storms at three identified locations. The flat peak of the graph for Railway culvert represents the capacity constraint of this culvert.

Due to lack of information available on the Grand Canal culvert at the time in 2005, it has been assumed that flow through this culvert discharges freely.

Based on the surveyed data the estimated pipe full capacities of three identified culverts are as follows:

Location	Capacity
Culvert Under Railway Line	0.34 m <sup>3</sup> / s
Culvert Under Millstream Road	11.00 m <sup>3</sup> / s (increased to 18.38m <sup>3</sup> /s with Twin 2.1 Culverts)
Culvert Under N4 National Primary Road	26.88 m <sup>3</sup> / s upstream and 42.61 m <sup>3</sup> / s downstream

Table 4.3 Full Capacity of **Existing** Culverts (as extracted from 2005/2008 Reports)

The hydraulic analysis results showed that: -

- i) the railway culvert is submerged upstream for both 30 and 100 year ARI storms.
- ii) the upstream end of the culvert flows are sub-critical with flows at downstream end super-critical.
- iii) The upstream end of the railway culvert is submerged for the large events and there is a free discharge at the downstream end of the culvert.

The system had also been analysed with the railway culvert silted to a depth of 700mm to check the sensitivity of the analysis. This obviously resulted in a reduction in the culvert capacity and the flow regime was predicted to change with sub-critical flows along the length of the culvert.

The report recommended that a cleaning programme of the railway culvert be carried out to avoid the loss of capacity through this culvert.

Table 4.4 shows the siltation results and reduced flows through the railway culvert.

Location	30 Year ARI Peak Flow (m <sup>3</sup> / s)	100 Year ARI Peak Flow (m <sup>3</sup> / s)
Flow from South of Grand Canal (Free Discharge)	1.76	2.62
Culvert Under Railway	0.126	0.126
Culvert Under Millstream	2.53	2.94
Culvert Under N4	2.63	3.07

Table 4.4 Predicted peak flow at various culverts with silt in Railway Culvert (as extracted from 2005 & 2008 Reports) (pre Development)

Based on the analysis of the models comparing the behaviour of the system, both with and without silt at the railway culvert, the models predict that the siltation causes more flooding of the channel upstream of the railways culvert and results in less flooding at the downstream locations of Tubber Lane Road and Lucan Golf Course. However further downstream i.e. at the Millstream culvert and the N4 culvert, there is no change of the flooding regime due to the presence/absence of the silt in the railway culvert.



The model results indicated the following return periods at which the identified culverts were flowing at full capacity: -

- a) The 200-year ARI was the largest return period storm.
- b) The 10-year ARI (240-minute duration) storm was the event at which the railway culvert was at full capacity.
- c) The small culverts along Tubber Lane Road flooded at various return periods (5, 10 or 50-year ARI) for the 30-minute event.
- d) The culverts under Millstream/Dodsborough Road and the N4 have sufficient capacity to convey even up to the 200-year ARI storm scenario.

#### 4.3.3 The River Liffey in Flood

In order to simulate extreme conditions, the model was also run to simulate discharge to the River Liffey with the river in flood. The 1954 flood is one of the largest floods on record in recent times and has been estimated previously as 200 to 250 years, however it is not clear whether this would be the return period for the River Liffey at Lucan.

The model showed that the N4 culvert does surcharge due to high water levels in the River Liffey, but that these high-water levels do not cause any surcharge or flooding further upstream in the Tobermaclugg-Backstown catchments. (due to the level difference between the River Liffey, Tubber Lane Road and the ASDZ

It is important to note that for any notable rainfall event, the times to peak for the Liffey catchment and the Tobermaclugg-Backstown catchment are significantly different. The rate of response of a catchment is based on a number of factors including:

- Catchment area;
- Length of the watercourse;
- Rate of runoff for the catchment; and
- Slope/grade of the channel.

Due to the relative size, length and the predominantly rural nature off the River Liffey catchment the time of concentration of the catchment is considerably greater than the Tobermaclugg/Backstown Streams.

Furthermore, the River Liffey is impounded at Poulaphaca, Golden Falls and Leixlip, managed and controlled by ESB.

Therefore, in a rainfall event occurring over both the Liffey and Tobermaclugg/Backstown catchments, it is extremely unlikely that the peak of the two floods will ever coincide at Lucan. Peak flows from the existing Tobermaclugg/Backstown catchment will have dissipated well in advance of peak flows from the River Liffey.

#### 4.4 POST-DEVELOPMENT MODEL SCENARIO

As can be seen in the reports generated prior to 2009, the initial *InfoWorks* models of the proposed developments of the ASDZ lands had been constructed for the two separate scenarios, of which **Scenario 2 B** was agreed with SDCC and adopted (Refer to the 2008 Report):

**Scenario 2** Tobermaclugg-Backstown catchments and the North-East sub-catchment draining to the Tobermaclugg Stream  
and the South-East sub-catchment draining to the existing 450mm  $\varnothing$  sewer.

Using the 2002 report "*Interim Design Report on Roads and Services*", a master plan for the storm water drainage was established and formed the basis for the study. The design criteria used to check the preliminary sizing of the sewers was as follows:

- No surcharge in 2 years Average Recurrence Interval (ARI) rainfall event, and
- No flooding in a 30-year ARI rainfall event within the ASDZ.

In the 2006 report the following additional criteria were added:-

- No flooding of the Lucan Golf Course in a 100 year ARI rainfall event
- No flooding of Tubber Lane Road in a 100 year ARI rainfall event
- No flooding of the proposed Tobermaclugg Pumping Station in a 1 000 year rainfall event
- A basic continuous flow in the Tobermaclugg Stream downstream of the old confluence point
- Use of 1954 flood level of River Liffey at discharge point of the Tobermaclugg Stream
- Continuous flow in the salmonid Tobermaclugg/Backstown Stream in the Golf Course

- **The stormwater culvert through the Lucan Golf Course will serve as the emergency outfall for the Tobermaclugg Foul Pumping Station**

For the proposed development the trunk sewers were modelled, as was the culverting of the Tobermaclugg Stream, with circular sewer from the railway culvert to the end of Lucan Golf Course.

Downstream of the Lucan Golf Course to the discharge point to River Liffey open rectangular channels are proposed. (*Refer to Appendix 1 in 2005 Report to see the Network schematic of the InfoWorks model of Scenarios 1 & 2.*)

Various durations and return periods were simulated to establish the critical duration storm for the post development scenario, in line with the GSDSDS, while making allowance for climate change by also including a 10% additional rainfall for each storm event and a 4% reduction in rainfall for the size of the catchment area (2006 report pg 4). For the **post development scenarios in 2005, a 540 min (winter profile) duration storm** was established as the **critical storm**. However in the **2006 Report** taking into account the adjustments to the model, **the 30 min winter profile for the 100 year ARI duration** was established as the critical storm for the culverts **downstream (Reach 2) of the Tobermaclugg Pump Station**. The **May 2006** report then assesses the options of the culvert system for **Reach 2**, to be the most cost effective with the least amount of disruption to local traffic.

The addendum report of **Oct 2006** made the following further adjustments and then minor tweaks in **April 2007** when the box culvert for the upper portion of Reach 2 was converted into a pipe culvert equivalent through the Lucan Golf Course: -

- i) Revision of the stream vegetation coefficients between the golf course & N4 culvert
- ii) Dimensions of the composite N4 culvert
- iii) The flow path & drainage mechanism for the Lucan Golf Course (This was the constructed 2.1m/2.4m  $\varnothing$  culverts past the Tobermaclugg PS through the Lucan

Golf Course and upgrading the arrangement of surface water pipes (900/750/600/300 ø) at Backstown Stream crossing of Tubber Lane Road to a 2.4 x 0.8 box culvert in late 2009/10).

In addition, two alternatives were also analysed as follows for both Scenarios 1 & 2:

**Alternative A** With the existing railway culvert in place.

**Alternative B** With an increase in the size off the railway culvert to remove the existing throttling effect at this culvert.

The models of the proposed alternatives to the system were run for a number of rainfall events up to the 100 years ARI storm.

For the purpose of the analysis of the system, the length of the stream has been divided into **two reaches**. These are indicated on Figure 3.3 and described below:

**Reach 1** Stream from railway culvert at southern end of ASDZ to the confluence point of Tobermaclugg & Backstown streams; and

**Reach 2** From the confluence point of the streams to the outfall point at the River Liffey.

#### 4.4.1 Scenario 2 B

As can be seen in the **2005 Report**, the **Scenario 2 B** model was simulated for both 30 year and 100-year ARI events. Peak flows at various sections were predicted with the use of the model, ***which had an increase in the size of the railway culvert to remove the existing throttling effect.*** Figure 4.5 below represents the catchment delineation for Scenario 2 B.

#### **Alternative 2B (With Upsized Railway Culvert):**

Table 4.5 below summarises results from the modeling of Scenario 2B.

Location	30 Year ARI Peak Flow (m <sup>3</sup> / s)	100 Year ARI Peak Flow (m <sup>3</sup> / s)
Flow from South of Grand Canal (Free Discharge)	1.76	<b>2.62</b>
Culvert Under Railway	2.54	<b>3.85</b>
Culvert Under Millstream	7.36	<b>10.31</b>
Culvert Under N4	7.44	<b>10.84</b>

Table 4.5 Scenario 2B (2005 Report) simulation Results

The results for Scenario 2B show:

- a) an increase in flows through the railway culverts and downstream of it, due to the additional capacity provided.
- b) The flows downstream increase by some 0.2m<sup>3</sup>/s at peak for the 30-year ARI.
- c) The peak flow increases for the 100-year ARI by some 0.53m<sup>3</sup>/s and 0.87m<sup>3</sup>/s for the Millstream culvert and the N4 culvert respectively.

The arch shape culvert under the railway is 900 mm x 750 mm.

- a) For the 100-year ARI, the culvert would need to be augmented with two 1050 mm ø pipe culverts.
- b) For the 30-year ARI, the culvert would need to be augmented with one 900 mm ø pipe culvert. (These upgrades are the same as those identified for Scenario 1B.)

The **2005 Report** compared the results for **Scenarios 1A & 2B** which showed that cumulative effect of

- i) upsizing the railway culvert, along with
- ii) discharging the **North-East catchment** to the **Tobermaclugg-Backstown catchment**,

would increase the peak flow for 100-year ARI storm by approximately: -

- 1.83m<sup>3</sup>/s at the **Millstream culvert** and
- 2.24m<sup>3</sup>/s at the **N4 culvert**.

The **2005 Report's** predicted hydrographs (Fig 3.13 and 3.14) reflects the Tobermaclugg-Backstown catchments for the 30 year and 100-year ARI storms at three identified locations respectively.

The initially proposed culvert sizes for **Scenarios 2B** are summarised in Table 4.6 below, where **Reach 1** (Approx 2087m) based on the original stream route through the ASDZ until the old confluence point and **Reach 2** is from the old confluence point to the discharge into the River Liffey. (See Fig E below which shows the respective reaches)

Reach	Culvert Size for 30 Year ARI		Culvert Size for 100 Year ARI	
	Length (m)	Description	Length (m)	Description
Reach 1	591	1 № 1350 mm ø.	591	1 № 1500 mm ø.
	1295	1 № 1350 mm ø	1295	1 № 1500 mm ø
	201	1 № 1350mm & 1 № 1500mm ø	201	1 № 1500mm & 1 № 1800mm ø
	<b>2087</b>	<b>Total length of Original Stream Route</b>	<b>2087</b>	
Reach 2	836	1 № 1350mm & 1 № 1500mm ø	274	1 № 1500mm & 1 № 1800mm ø
	69	1 № 1350mm & 1 № 1800mm ø	631	2 № 1800 mm ø
	76	2.9m x 1.7m rect. open channel	76	2.9m x 1.7m rect. open channel
	31	3.6m x 1.2mm rect. open channel	31	3.6m x 1.2m rect. open channel
	<b>1012</b>		<b>1012</b>	

**Table 4.6 Proposed culvert size for Scenario 2B for 30 & 100 Year ARI (2005 Report).**

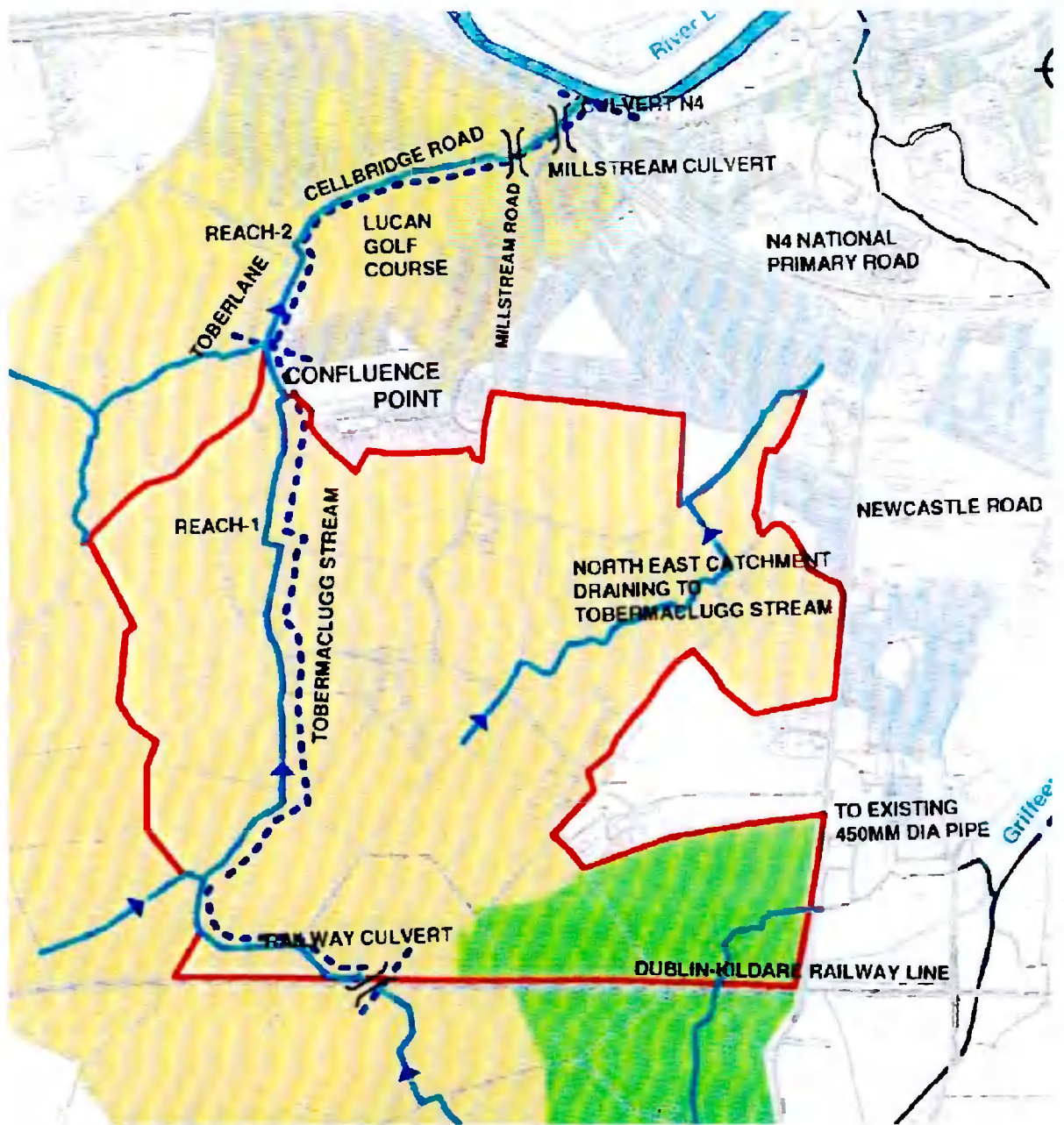


Figure E - Reflecting the Reach 1 & 2

#### 4.4.2 The River Liffey in Flood

- i) The preliminary sizing of the surface water system (for both the proposed sewers and the proposed Tobermaclugg culvert) was based on free discharge from the drainage system to the River Liffey.

- ii) To test the system for an extreme event, the model was simulated with boundary conditions at its outlet, setting the 1954 flood level in the River Liffey as a boundary condition.
- iii) The 1954 event was an extreme event as it is the only historic flood level available at the location of interest in the River Liffey.
- iv) The model showed that the culvert would be submerged downstream of the N4 throughout the event, but it would not cause any flooding upstream of the catchment due to the significantly higher invert levels of the sewers upstream of the N4 culvert.

The **2005 Report's InfoWorks** Hydrograph's (Figure 3.15) reflected the predicted flows for the discharge point of Tobermaclugg/Backstown Stream to the River Liffey under free discharge for the various scenarios for the 100-year ARI storm. For comparison, the corresponding hydrographs for the existing (undeveloped) situations are also included in the figure.

Flow estimates for two extreme historical events are available for the River Liffey, upstream of Lucan.

- i) The December 1954 was estimated to be some 175m<sup>3</sup>/s and
- ii) the November 2000 flows estimated to be some 190m<sup>3</sup>/s.

For comparison, the predicted flows for the 100-year ARI for the various scenarios, demonstrates that the flows for the Tobermaclugg/Backstown catchment, even in extreme events, are small in comparison to the flows in the River Liffey.

**2005 Report's InfoWorks** Hydrographs (Figure 3.16) exhibit the estimated flows in the River Liffey for two extreme historical rainfall events: December 1954 and November 2000.



#### 4.4.3 Selection of the Post- ASDZ development Scenario

Based on discussions with SDCC and the design engineers at the time regarding the possibility of the railway culvert being upgraded to accommodate flows for the 100-year ARI event, it was agreed that **Alternative B** be adopted, whether it is for Scenario 1 or Scenario 2. The requirements of Scenarios 1B & 2B in terms of the culvert size, based on Table 3.7 and 3.11 can be summarised as follows:

- In **Reach 1** the first 1,886 metres of culvert is to be a 1500  $\emptyset$  culvert for both scenarios; (A 1500 $\emptyset$  pipe has been installed from the entry point into the ASDZ until the temporary Park & Ride)
- Immediately downstream of the above within **Reach 1** the following 201 metres is sized for **Scenario 2B requiring 1 no. 1500 mm  $\emptyset$  and 1 no. 1800 mm  $\emptyset$  culvert**; (in the detailed design process a 2.1m  $\emptyset$  pipe installed for approx. 490m – this equates to 21 800 l/s at a grade of 1 :70 Ks = 0.6)
- The upstream end of **Reach 2** has been sized for **Scenario 2B** is sized as 274 metres of 1 no. 1500 mm  $\emptyset$  and 1 no. 1800 mm  $\emptyset$  culvert followed by 631 metres of twin 1800 mm  $\emptyset$  culverts. (During detailed design and consultation with SDCC, 2.4m $\emptyset$  was installed for 846m has a capacity of 24 500 l/s at grade 1 :111 Ks = 0.6)
- The 107 metres of open channel through Lucan Golf Course for both scenarios, comprises of 76 metres of 2900 x 1700 mm, followed by 3600 mm x 1200 mm open channel.

Following the amendments to the model in the Oct 2006 report to take into account the adjusted vegetation co-efficient, the actual N4 culvert dimensions and the drainage mechanism through the golf course, the following amendments were incorporated into the design and subsequently constructed:-

- a) Replacement of the Millstream culvert with twin 2.1m box culverts (partly buried to 300mm below the existing stream bed to preserve existing salmonoid habitat)
- b) Excavation of proposed attenuation pond (to maximum possible storage volume with property boundaries, maintain a min of 300mm depth in the existing channel) immediately upstream of the Millstream culvert
- c) Construction of a bund max 1m along the left overbank of the Stream along Celbridge Road between the Millstream culvert and the N4 culvert to 26.0 m OD (assuming  $\frac{1}{2}$  m freeboard).

- d) Preservation of the natural state of Stream between the Millstream culvert and the N4 culvert
- e) Removal of the 750mm $\varnothing$  pipe channelling flows from the Lucan Golf Course with flows to fall directly into the proposed Millstream attenuation pond.

#### 4.4.4 Adjustments to Model between Tobermaclugg PS and the River Liffey

Adjustments were continually made to the model using the latest information to analyse the stormwater flows between the Tobermaclugg PS and the River Liffey and were taken into account when developing the construction options as reflected in the 2008 Report.

It was noted that there is close interaction between the Tobermaclugg Foul Water Pump Station and the design of the Surfaced Water outfall past the PS, so changes to the design of either one of these elements impacts on others and the way they function. During the design process, the following were proposed:-

- a) To culvert all the stormwater flows from the ASDZ within 2.4m  $\varnothing$  culverts in **Reach 2** from the Tobermaclugg PS to the north eastern end of the Lucan Golf Course.
- b) To contain a continuous flow of 100  $\ell/s$  in the Tobermaclugg Stream upstream of the old confluence point with the Backstown Stream in order to maintain an environmentally sustainable watercourse through the ASDZ.
- c) To leave the existing Tobermaclugg and Backstown Stream, downstream from the point where they meet on Tubber Lane Road, unchanged (Except for the increase in culvert size for the Tubber Lane Road crossing –see e) below). However it was recommended that this section be cleaned to restore its original condition.
- d) To retain the old confluence point between the Tobermaclugg and Backstown Stream in order to maintain the 100  $\ell/s$  in the Tobermaclugg Stream
- e) To upgrade the existing 900/750/600/300 $\varnothing$  pipe configuration crossing of the Backstown Stream of Tubber Lane Road, (the entrance grating which was completely

blocked during the 2009 flood event and was the primary cause of the flooding), was upsized to a 2.4 x 0.8 box culvert when the full extent of the Backstown Stream catchment was confirmed.

- f) The removal of the Lucan Golf course flows to the water feature (pond) on the eastern boundary of the golf course, closest to the Millstream culvert
- g) The stream was widened and banded between the Millstream culvert and the N4 Culvert. The rest of the route to the discharge point to the River Liffey remained unchanged.
- h) It also mentioned limiting the flow at the PS to 12m<sup>3</sup>/s to prevent flooding of the Lucan Golf Course
- i) The incorporation of a 5000m<sup>3</sup> attenuation pond based on the results of the model.

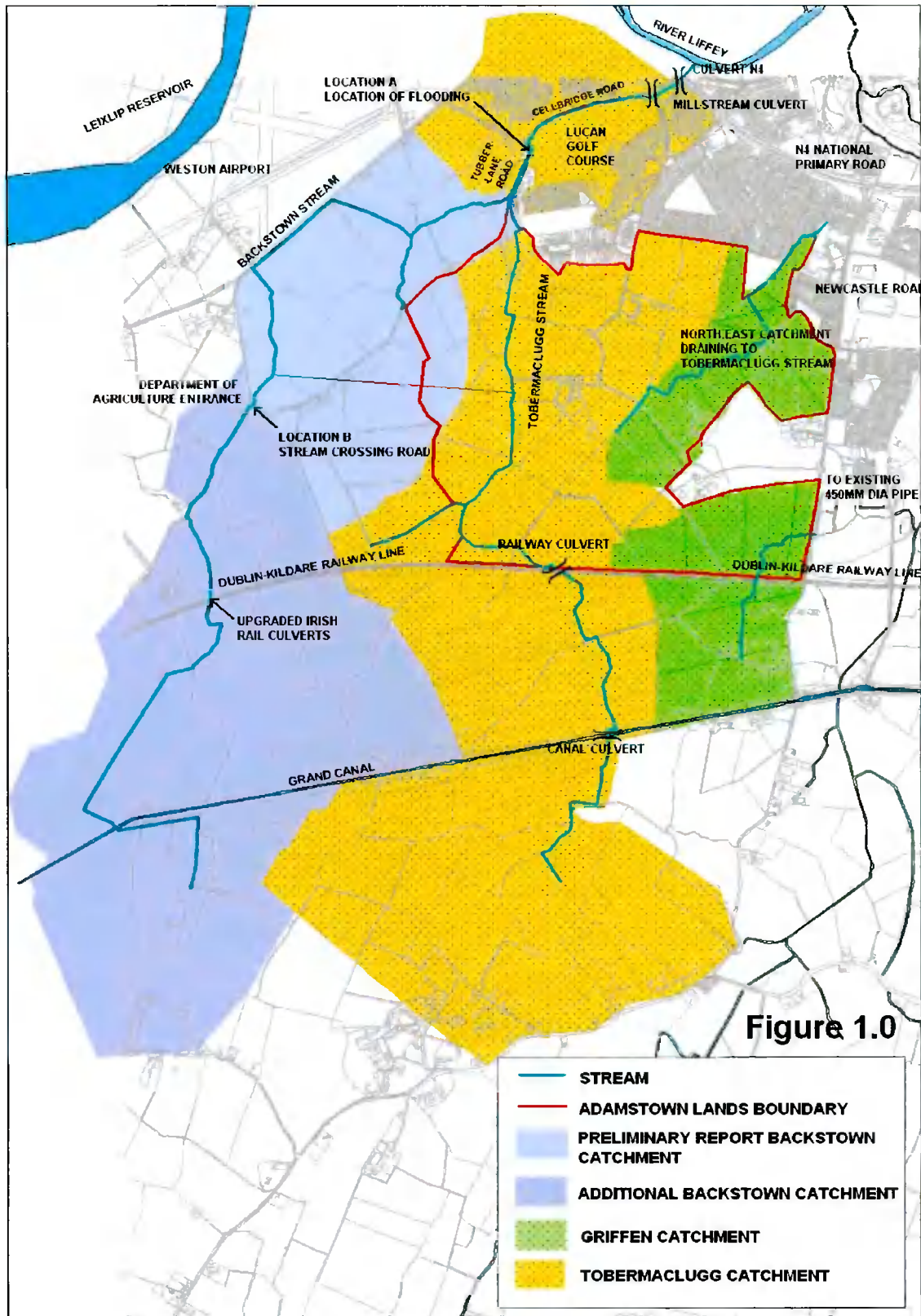
#### 4.5 UPDATED 2010 CATCHMENT MODEL

The survey data recorded in January 2010 was collated and input to the existing *Infoworks* model to assess the existing pipe network and attenuation pond, and to examine the potential impacts on flooding on Tubber Lane Road. The revised model was developed with the existing enlarged catchment area and existing structures information from the survey.

##### 4.5.1 Design Storm –Updated for Backstown Stream Adjusted Catchment

The revised model estimates a flow of 4m<sup>3</sup>/s in the Backstown Stream in the 100-year ARI event at Tubber Lane Road. This volume is generated because of the following:

- Catchment Area Revision
- Upstream Structure Construction at the railway crossings
- Channel Cleaning
- Office of Public Works (OPW) Climate Change Requirements +20%. (Greater Dublin Strategic Study (GSDSDS) Regional Drainage Policies Require only a 10% increase in rainfall intensity for climate change.)



#### 4.5.2 Reassessment of Attenuation Pond North of Lucan Golf Club

Following the reassessment after 2009, the model indicated that the Backstown and Tobermaclugg Streams have different response times to storm events. **The critical storm duration for the Tobermaclugg and Backstown Stream catchments are the 60 min and 1220 min storm respectively.** The Tobermaclugg Stream catchment dictates the attenuation pond's capacity due to the volume of runoff estimated and the faster response of the catchment, the 60min storm is shown graphically in Figure 5.5 below. Because of the varying critical storm durations the increased Backstown Catchment area does not increase the attenuation volume requirement.

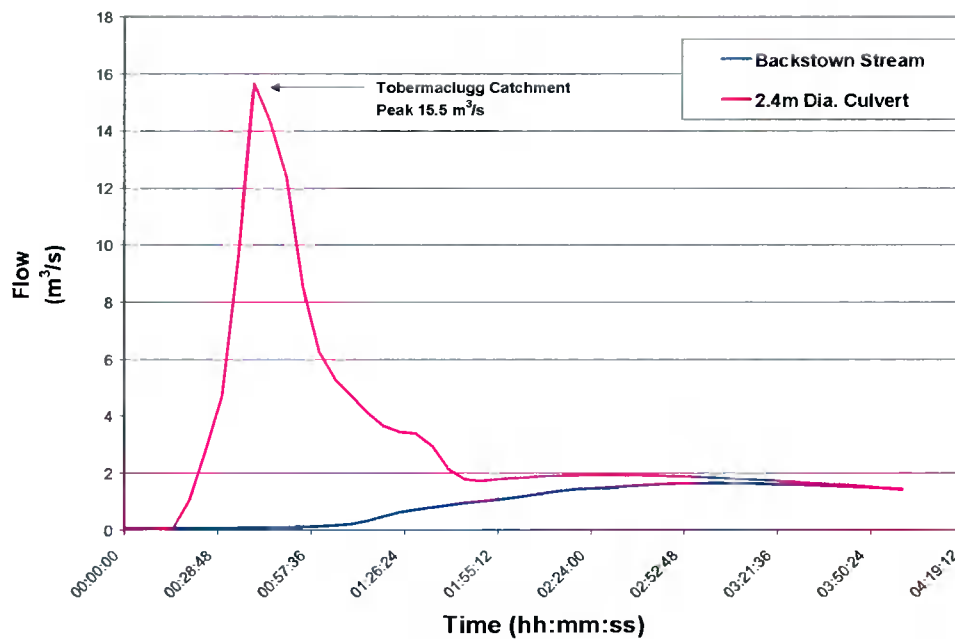


Figure 5.5 Catchment Storm Profiles

When examining the attenuation pond, it should be noted that a new 750m  $\varnothing$  pipe has been constructed as part of the N4 road upgrade which now discharges to the N4 culvert. The impact of this pipe will depend on its contributing catchment and its response to storm events. Tobermaclugg Stream

The Tobermaclugg Stream catchment consists of 486 ha, which represents 54% of the revised current model of Backstown–Tobermaclugg catchment (902 ha) and includes the ASDZ lands.

The stream is conveyed to the River Liffey via the new 1.5m, 2.1m / 2.4m  $\emptyset$  culvert system constructed as part of the Tobermaclugg Surface Water Drainage Scheme.

A reduced maximum flow of circa 100  $\ell/s$  is permitted in the existing stream channel, which passes through the Tobermaclugg Foul Water pumping station site. The flow in the stream is prioritised for environmental requirements.

The diversion of the Tobermaclugg Stream into the 2.1m / 2.4m  $\emptyset$  culvert is constructed within the Adamstown SDZ and then runs through Lucan Golf Course and is vital to reduce downstream flooding in Tubber Lane Road. All but 100 $\ell/s$  has been removed from the old confluence point. The rest of the flows only re-joins the stream at Millstream road where the 2.4m  $\emptyset$  culvert discharges into the attenuation pond.

#### 4.6 BACKSTOWN STREAM

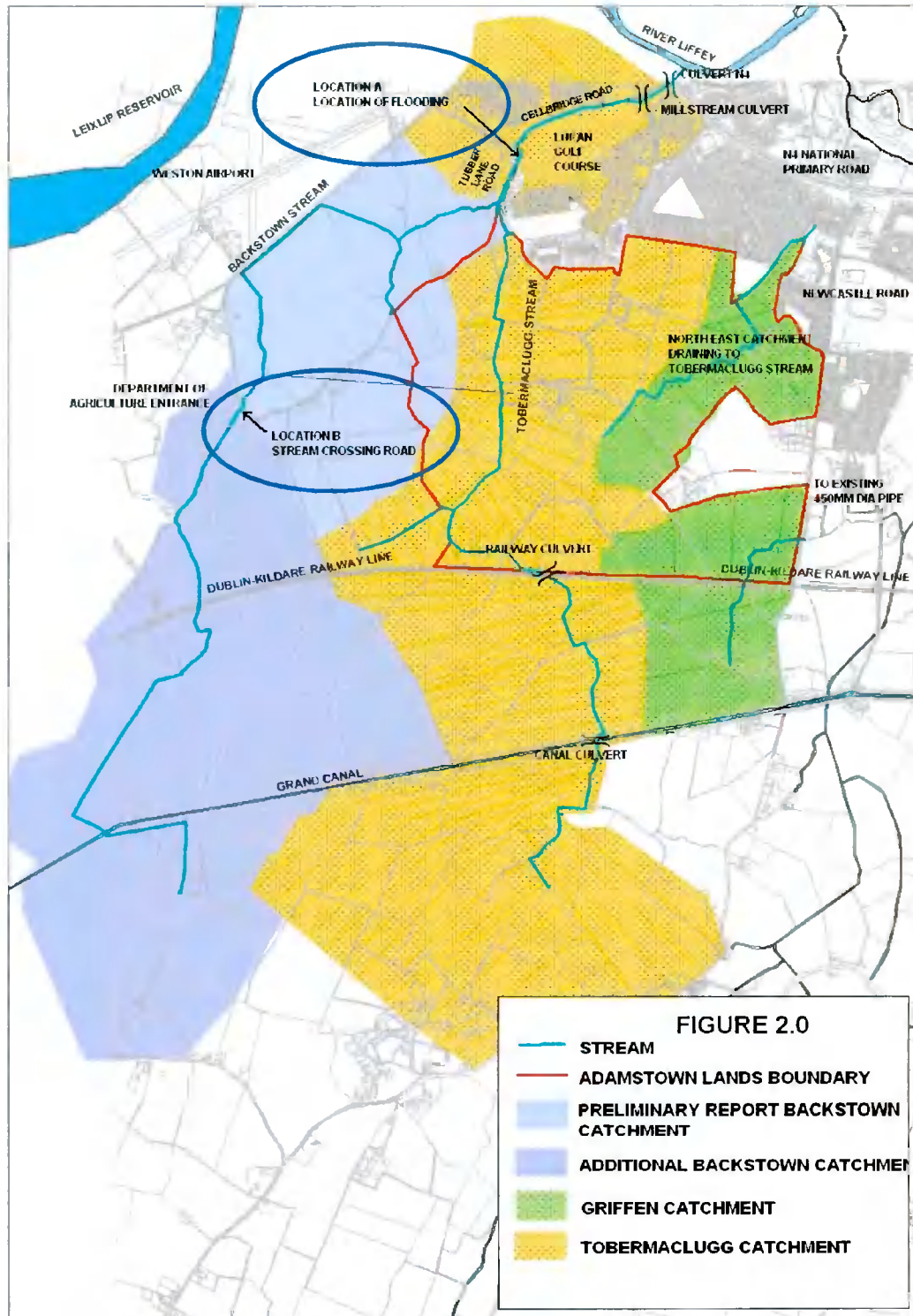
The Backstown Stream consists of a 416 ha catchment or approximately 46% of the contributing catchment area. The earlier reports and simulation model erroneously reflected a catchment area of only 126 ha. (There is no obvious reason for this error and it would appear to have been an oversight when determining the extent of the Backstown Stream Catchment). Downstream of the old confluence point of Backstown Stream and the Tobermaclugg Stream, the stream ditch was culverted, initially through a series of 225mm and 300mm  $\emptyset$  pipes, at various locations where it crossed driveways and accesses to the private properties flanking Tubber Lane Road. The development areas at the time, included Airlie Heights, Woodview Heights, Kew Park Crescent and Western Meadow, which discharge storm water into Tobermaclugg Stream at various locations en route.

In 2007/8 surface water pipe culverts (2.4m  $\emptyset$ ) were installed through the Lucan Golf Course into which the bulk of the Tobermaclugg Stream (except for 100  $\ell/s$ ) was diverted upstream from the original confluence point on Tubber Lane Road, to now join the Backstown Stream to the North of the Lucan Golf Course, south of the Millstream Road.

Observations during storm events in November and December 2009 led to a re-examination of the above-mentioned catchment areas to determine the cause of the flooding. Significant flows causing flooding of the Tubber Lane Road were noted where the stream crosses Tubber Lane Road at **Location B**, as well as at **Location A** (Figure 2.0 below), where the stream passes through Lucan Golf Club. The stream's source is adjacent to the Grand Canal and it was noted that this contributes an additional area of 290 ha to the Backstown catchment as shown in Figure

2.0. below As stated in the report, **Location A** was addressed by increasing the Culvert size to a 2.4 x 0.8 box culvert in 2010 as the primary cause of the flooding was the blockage of the existing stream and entrance into the 900mm pipe. A new 900mm  $\varnothing$  concrete culvert was installed after 2008 at **Location B** at the entrance to the Department of Agriculture Lands

The combined Tobermaclugg – Backstown stream catchment actually equates to a total of 902 ha (i.e 486 ha + 416 ha = 902 ha) as can be seen below.



## 5. Review of Engineering Reports and findings

In 2005 PHMcC completed a report titled “**Assessment of the Tobermaclugg Stream Upgrade to the River Liffey**”. The report’s main focus was: -

- a) to examine options for the **Tobermaclugg Stream upgrade** as part of the ASDZ.
- b) to develop proposals as set out in the 2002 PHMcC report entitled “**Interim Design Report on Roads and Services**”.
- c) to alleviate the existing flooding issues on Tubber Lane Road.

The **Backstown Stream**, which converged with the Tobermaclugg Stream on **Tubber Lane Road**, was also included in the study although no development was planned for its catchments at the time, as the combined flow traversed the downstream 1110 m to its discharge point at the River Liffey.

The **May 2006 PHMcC Report** progressed on the initial 2005 Report, as detailed design and discussions with SDCC progressed to accommodate the surface water run-off of the ASDZ lands and to alleviate the localised flooding on Tubber Lane Road.

- a) It further developed the proposed surface water drainage upgrade
- b) focused on the proposals for the Tobermaclugg Steam downstream of the old confluence point with the Backstown Stream on Tubber Lane Road, resulting in the incorporation of a **5,000m<sup>3</sup> attenuation pond** at Millstream Road below the Lucan Golf Course,
- c) The strategic *Infoworks* CS stormwater simulation model developed at the time for the contributing catchments, was based on available contour plans, OS mapping and aerial photography.
- d) A separate report “**Tobermaclugg Pump Station Preliminary Report – May 2006**” has been prepared and should be read in conjunction with this report.

Following an **Addendum Report in Oct 2006**, further design enhancements were considered after receiving queries relating to :-

- i) the drainage mechanism within the golf course,



- ii) the actual composition of the N4 culvert and
- iii) requirements by SDCC **not to discharge stormwater to the storage tanks at the Tobermaclugg Foul Water Pumping Station (PS)**. (See below a map reflecting the location of the attenuation pond and the old confluence point of the Tobermaclugg Stream with the Backstown Stream relative to the Lucan Golf Course.)

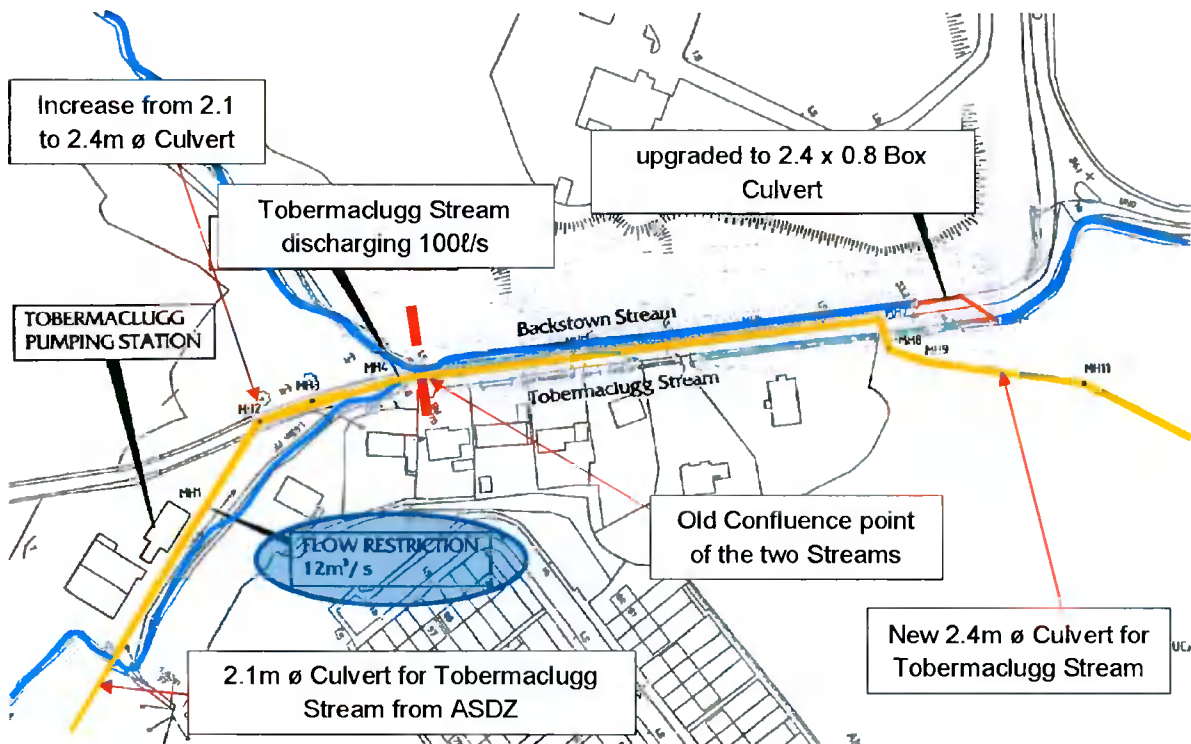
A further Report (titled “**Tobermaclugg Stream Upgrade Preliminary Report Addendum**”) was prepared in **April 2007**, which indicated :-

- i) the final route selection
- ii) the conversion of initial box culverts design to equivalent pipe sizes of 2.1m/2.4m for part of the **Reach 2** alignment of the Tobermaclugg Stream through the Lucan Golf Course, along with
- iii) the upsizing of the Millstream Culvert to Twin 2.1m box culverts.

The culvert system constructed for the **Tobermaclugg Surface Water Drainage Scheme** conveys the bulk of the Tobermaclugg Stream flows away from Tubber Lane Road and has been designed to convey surface water runoff from the developed ASDZ lands. As part of the ASDZ design Strategy, it was agreed to maintain flow (approx. 100 l/s) in the Tobermaclugg Stream, where possible in the design of the various ASDZ development tiles/areas – (See **Figure X.1** in **Section 4.1** above, showing the proposed route via which the final stream alignment will pass through the **Adamstown Boulevard, Aderrig, Tobermaclugg Village, Tobermaclugg Park** and **Airlie Park** SDZ Development Tiles). By diverting the bulk of the Tobermaclugg Stream and surface water flows into a new piped system, the volume of surface water on Tubber Lane Road had been reduced substantially as the Backstown Stream is now the main watercourse contributing to the stream at the “Old” confluence point on Tubber Lane Road. The two streams now primarily converge at the attenuation point south west of the Millstream Road (bar the agreed 100 l/s) and the combined flow then traverses through the attenuation pond and existing ditch / culvert system for now only the final 230m of the original route, prior to the upgrade works carried out to date.

The plan below shows **Tubber Lane Road** through the Lucan Golf Course relative to the ASDZ Tobermaclugg Foul Water Pumping Station. Note the following:-

- a) the location of the "old" confluence point,
- b) the route of the 2.1 m /2.4m culvert into which all but 100 l/s of the Tobermaclugg Stream (85% of the ASDZ contributing area) flows, and
- c) the location of the new 2.4m x 0.8m culvert Tubber Lane Road crossing for the Backstown Stream (upgraded in 2010).



Plan A1 – Location of Backstown Stream and old Confluence Point with Tobermaclugg Stream



Fig A2 – Location of Backstown Stream and old Confluence Point with Tobermaclugg Stream

In **Early 2008** a further report was issued titled ***"Tobermaclugg Stream Upgrade Preliminary Report (revised)"***. In this report :-

- i) the proposal of the Tobermaclugg Stream upgrade and future drainage of these developed lands downstream from the Tobermaclugg Pumping Station are identified and on this basis, the design was agreed with SDCC Drainage Department, Part 8 Planning consent obtained and the scheme implemented/constructed in 2008/9 under supervision of SDCC Drainage Department.
- ii) One of the two simulated models relates to the post-development scenario and its effects on the Tobermaclugg Stream from the Tobermaclugg Foul pumping station to its discharge point at the River Liffey (See above in Fig A2).

- iii) six possible scenarios and alternatives had been considered to date (and taking into account all the design enhancements between 2005 and 2008), **Scenario 2 B** was adopted as the most critical and likely to occur.

**Scenario 2** Tobermaclugg-Backstown catchments and the (ASDZ) North-East sub-catchment draining to the Tobermaclugg Stream

and the (ASDZ) South-East sub-catchment draining to the existing 450mm  $\varnothing$  sewer (mostly developed except for the western end at the time of this report).

**Alternative B** With an increase in size of the railway culvert to remove the existing throttling effect at this culvert.

The Tobermaclugg Stream upstream, from its entry into the ASDZ on its southern boundary until its discharge at the "old" confluence point with the Backstown Stream, would be fed with a continuous flow of 100  $\ell$ /s to maintain this stream as an environmentally sustainable watercourse. This would be achieved by diverting only 100  $\ell$ /s into the realigned Tobermaclugg Stream through the ASDZ in accordance with the SDCC Planning scheme. The rest of the flows would be diverted into the underground pipe network (installed under mainly the following planning permissions: SDZ05A/2, SDZ 06A/4, SDZ06A/5 & SDZ 06A/11) and with future planning applications.

- a) This would result in the removal of the bulk of the flow at the old confluence point on Tubber Lane Road bar the 100 $\ell$ /s.
- b) The existing Tubber Lane Road crossing of the Backstown Stream was upgraded from a 900/750/600/300  $\varnothing$  pipe configuration to a 2.4m x 0.8m culvert in 2009/10 following the finding of the increased Backstown Stream Catchment area) in addition to the 2.1/2.4m  $\varnothing$  pipes installed past the newly constructed ASDZ Tobermaclugg Foul Pump Station through the Lucan Golf Club as part of a Part 8 Planning Consent with SDCC.
- c) A 60-minute 100-year (winter profile) ARI duration storm was established as the most critical for the culvert downstream of the Tobermaclugg Foul Water Pump Station
- d) Environmental risks were also identified in relation to the pollutants from run-off paved areas caused by storm washing oils, grease, grit and organics, it was indicated that appropriate sized "Storm King" type "*Downstream Defenders*" be installed at strategic

locations on the stormwater sewers within the ASDZ. Some of these "Defenders" have already been installed in the South East and Tobermaclugg Catchments. (See Appendix B)

In **November and December of 2009** certain elements of the historical flooding problem recurred on the public road (Tubber Lane Road), which passes through Lucan Golf Course, and as a result, further investigations were carried out.

A **Report in 2010** was prepared by **WYG** (formerly PH McCarthy Consulting Engineers) following a thorough reassessment of the whole surface water system and it was determined that the following factors combined to contribute to this particular flooding: -

- ii) following intensive site investigations to determine the cause of the recent flooding in 2009 on Tubber Lane Road, it was noted that a reduced catchment area was used in error at the onset to determine the extent of the Backstown Stream Catchment Area,
- iii) additional new, larger culverts had been installed under the railway lines to the south of the ASDZ, which had reduced the attenuation effect/time of concentration of the previous smaller culverts. (This did not have any direct impact on the flooding that occurred on Tubber Lane Road as the Tobermaclugg Stream is now piped passed the area of flooding and away from the old confluence point. From the assessment, It was confirmed that no additional flow from the Tobermaclugg Stream contributed to the flood waters as the diverted system was intact.)
- iv) reduced openings along the base of the re-erected stone wall along the eastern side of Tubber Lane Road had restricted run off from the road and ditch on the western side of the road and into the stream to the east of the reconstructed wall. These were addressed by reconstructing larger openings in the base of the wall in 2010 –See Fig A5 below.



Figure A3 Before Works 2005



Figure A4 After Wall Reinstatement 2008



Figure A5 New Opes After Wall Reinstatement 2010

- v) pipe restrictions in the form of significant amounts of debris, hedge clippings and plywood, were removed from the surface water system by Chartridge Developments and SDCC in December 2009,
- vi) cleaning of the screen installed on the inlet of 900mm  $\varnothing$  culvert at the Tubber Lane Road (This culvert was upgraded to a 2.4 x 0.8 box culvert in 2010)

- vii) the construction of an Arched Bridge over the stream within the Golf Course, (It would seem that no thought was given to the potential restriction this structure would have when the shape or size was designed and constructed. However, it would seem that this is not a critical factor but a possible contributory factor to the flooding that occurred in 2009.)



Figure A6 Arch Bridge

- viii) it is worth noting that a temporary overflow constructed within the ASDZ lands near Adamstown Way to divert the stream into the pipe network upstream from the 2.1m / 2.4m  $\varnothing$  pipe culvert, was breached during the flooding event of 29<sup>th</sup> November 2009 and resulted in greater than anticipated downstream flow.
- a. Despite this breach, the Tobermaclugg Stream did not flood south of the "old" confluence point with the Backstown Stream as had regularly occurred prior to the construction of the piped Tobermaclugg Surface Water Drainage scheme in 2008.
  - b. As a precaution, and to reduce downstream flows, an emergency bund was constructed on the 29<sup>th</sup> Nov '09 and this rectified the breach by redirecting flows into the 2.1m / 2.4m  $\varnothing$  culvert system. (This bund continues to control the stream flow well, as was demonstrated in the heavy rainfall events of the 29<sup>th</sup>/30<sup>th</sup> Dec'09.) (However this bund will be removed when the area in question is subsequently enveloped by development in accordance with the SDZ Planning Scheme.)

- ix) Therefore it can be noted that the 2009 flooding that did occur seemed to be primarily related to:-
- a. The increased area to the Backstown Catchment (however this area is in theory the same as it was prior to any development in ASDZ. It is not as if any physical adjustments were made to increase the contributing area, just an oversight to the extent of the actual catchment.) However, the 900Ø pipe crossing Tubber Lane Road was increased to a 2.4 x 0.8 box culvert to increase the capacity of the road crossing)
  - b. Debris blocking the stream and a combination of lack of general maintenance was the primary causes of the flooding of Tubber Lane Road as the waters were simply blocked/contained due to the debris. (The new box culvert installed was oversized to minimise the occurrence of blockages which had occurred on the 900mm pipe.)
  - c. A programmed maintenance assessment strategy needs to be considered and implemented by SDCC.
  - d. In accordance with the findings, maintenance actions need to be set out and carried out to ensure that there are no restrictions to the system.

PHMcC had **prepared drawing SK121 (Overall Storm Sewer System)** which reflected a schematic of all the surface water sewers installed under the respective ASDZ planning permissions. **Waterman Moylan Engineering Consultants Limited** have taken this drawing and updated it to reflect the surface water sewer network installed to date as at November 2017. **(See Appendix A)**



## 6. CONCLUSIONS & RECOMMENDATIONS

- 1) This report provides an overview of a number of alternative design scenarios considered from 2005 - 2009 for the storm water system of the ASDZ lands to the River Liffey via Tubber Lane Road/Lucan Golf Club following extensive consultative process with the engineers at PHMcC and SDCC before works were carried out.
- 2) Hydraulic models were constructed and analysed using *InfoWorks CS*, in line with the methodologies used in the Greater Dublin Strategic Drainage Study (GDSDS) and then updated periodically, following amendments, whilst designing the Tobermaclugg Foul PS to service the ASDZ and construction details for the culverted system.
- 3) A series of reports and models of the existing Tobermaclugg-Backstown catchment were produced with the use of a topographical survey, the existing drainage records and conclude as follows:
  - i) The total catchment is 902 hectares
  - ii) The simulation model was run with a number of storms with various durations (30, 60, 90, 120, 240, 360, 480, 540, 720, 1440, 2160 and 2880 min) and return periods (1, 2, 5, 10, 30, 50, 100 and 200 years) for the assessment of the critical duration storm.
  - iii) The 30 minute 100 year ARI duration (Winter profile) was the critical storm for the design of the culverts downstream of the Tobermaclugg PS (portion of Reach 2) based on the Tobermaclugg Catchment Area.
  - iv) The 1200 minute 100 year ARI duration (Winter profile) was the critical storm for the Backstown Catchment when sizing the Tubber Lane Road Culvert. In the analysis it was noted that the critical storms are not the same and do not coincide, therefore the attenuation and capacity of the culverts downstream of the new confluence point where the combined Tobermaclugg and Backstown Catchments discharge has sufficient capacity.
  - v) No information was available on the Grand Canal culvert and it is assumed to have adequate capacity to pass forward all flows. The railway culvert is a significant throttle on the system and furthermore can result in flooding of lands upstream of the culvert. The remaining significant culverts are of sufficient capacity up to the 100 year ARI.

- vi) Sensitivity analysis of the railway culvert situation demonstrates that siltation does significantly reduce flows through the culvert and causes further flooding of lands upstream of the culvert. It is recommended that a regular programme of maintaining full flow in this culvert is carried out i.e. removal of silt, vegetation etc.
- vii) The analysis takes into account Climate Change, allowing an additional 20% increase in rainfall intensity for the design of both the Millstream Road and Tubber Lane Culverts as per the OPW Section 50 requirements.
- viii) The analysis for the ASDZ takes into account an additional 10% increase in rainfall intensity for climate Change as reflected in Greater Dublin Strategic Study (GDSDS) Regional Drainage Policies.
- ix) The impact of the River Liffey has also been examined for all the alternative design scenarios. Whilst in extreme flood the river does surcharge the N4 culvert, it does not impact on the catchment further upstream due to the hydraulic grade line and the level difference.
- x) The runoff from the development lands in time of extreme rainfall is found to be insignificant in comparison to flows in the River Liffey. Furthermore any peak response in the Tobermaclugg-Backstown catchment will have reached the River Liffey much earlier than the peak response of the river to the same event.
- xi) By implementing the improvements and works below, it is predicted that flooding of Tubber Lane Road will not occur in storm events up to a 100 year ARI and that the Tobermaclugg PS will be protected against flooding for a 1000 year storm event.
- xii) Pollution Control – Consideration has been given to address the risk of pollution from run-off of paved areas. This is primarily caused by the initial rainfall in any storm washing oils, grease, grits and organics into the system. To protect the watercourses in the area, appropriately sized “Storm King” type downstream defenders are to be installed at strategic locations on the stormwater sewers within the ASDZ.
- xiii) Provide a 5000m<sup>3</sup> attenuation and reed planted as secondary treatment pond

4) Following extensive consultation with SDCC, including the Part 8 Planning Tobermaclugg Surface Water Scheme Upgrade, and based on all reports and models to date, the following works have been designed and constructed (and supervised by SDCC representative):

- i) The culverting and upgrading of the Tobermaclugg Stream from the Railway to the N4 culvert was designed and constructed to replace all existing small culverts and open channels which were prone to flooding.
- ii) The culverts have been designed and constructed so as not to cause flooding along Tubber Lane Road as they removed all but 100ℓ/s from the Tobermaclugg Stream upstream of the Backstown confluence point.

- iii) The Tobermaclugg Stream culverts have been designed to accommodate flows for the 100 year ARI with the railway culvert upgraded to accommodate the 100 year ARI.
- iv) An emergency foul water overflow from the Tobermaclugg Pumping Station into the 2.1m  $\emptyset$  surface water pipe with a 450 $\emptyset$  pipe dry weather discharge point immediately upstream of the discharge point of the 2.4m pipe at the attenuation pond to prevent pollution of the pond and stream between the Golf Course and the Liffey in case of a discharge of foul water from the Tobermaclugg PS.
- v) A bund wall of 1m has been constructed along the left overbank of the Stream along Celbridge Road between the Millstream culvert and the N4 culvert to 26.0 m OD (assumes  $\frac{1}{2}$  m freeboard).
- vi) Debris and material has been excavated along the left bank between the Millstream culvert and the N4 culvert to increase capacity
- vii) The Millstream Culvert has been upgraded to two 2.1m box culverts.
- viii) A 2.4m  $\emptyset$  pipe has been installed through the Lucan Golf Course to its discharge point at the Millstream Culvert
- ix) A 2.1m  $\emptyset$  pipe has been installed from through the Tobermaclugg Park pas the Tobermaclugg Pumping station to Lucan Golf Course
- x) A series of 1.2m, 1.5m & 2.1m  $\emptyset$  pipes have been installed from the Railway Culvert to Tobermaclugg Pumping station.
- xi) The combined Tobermaclugg/Backstown Stream crossing of Tubber Lane Road has been upgraded from a blocked 900 $\emptyset$  pipe to a 2.4 x 0.8 box culvert
- xii) Low flow channels (100  $\ell$ /s) at ground level and above the culverted of the Tobermaclugg stream have been provided and incorporated into the design. These channels have and can be constructed to convey base flows through the development lands where required. The underground culverts convey the additional storm and development flows.
- xiii) A 5000m<sup>3</sup> attenuation and reed planted secondary treatment pond has been constructed at the northern end of the Lucan Golf Course.
- xiv) Downstream defenders have been, and will be installed at strategic locations as the primary protection against pollution.

Given the scale and significance of the Adamstown Strategic Development Zone, the development and its surrounding surface water catchments have been fully analysed and a fully engineered system designed and constructed to manage and control the storm and development flows in order to reduce flood occurrences and protect against pollution of the bio-systems of the watercourses.

Significant investment has been made in the system and it meets the requirements of the Adamstown SDZ Planning Schemes and Greater Dublin Drainage Strategies to prevent flooding and protect the environment. Further attenuation and Downstream Defender units are required and are being installed in the North east and South east catchment areas. The largest western SDZ catchment does not require any further attenuation to prevent flooding above the regional attenuation and secondary treatment installed. However, it does require additional primary pollution protection in the form of additional Downstream Defenders as the development progresses.

## Appendices

**A. Overall SDZ Drainage Layout SK121**

## B. Downstream Defenders

## Downstream Defender® Advanced Hydrodynamic Vortex Separator

The Downstream Defender® is an advanced hydrodynamic vortex separator for the effective and reliable removal of fine particles, oils and other floatable debris from surface water runoff.

Its innovative design delivers high efficiency across a wide range of flows in a much smaller footprint than conventional or other swirl-type devices and it is the perfect choice for any catchment likely to convey high quantities of contamination.

1. Access for removal of floatables and sediments.
2. Inlet pipe.
3. Inlet chute.
4. Centre shaft.
5. Dip plate.
6. Centre cone.
7. Benching skirt.
8. Floatables and oil storage.
9. Isolated sediment storage zone.
10. Outlet pipe.

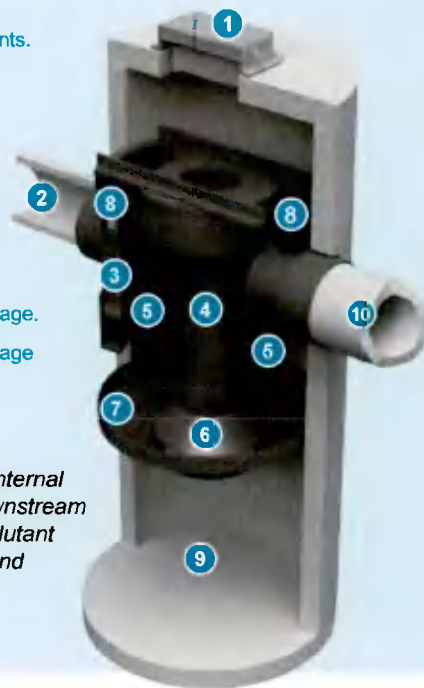


Figure 1 - The unique internal components of the Downstream Defender® enhance pollutant removal performance and prevent wash out.

### Unique Flow Modifying Components

The Downstream Defender® consists of a structural concrete chamber with unique flow modifying internal components. It is these internal components that differentiate the Downstream Defender® from catchpits, sedimentation basins or sedimentation sumps. They facilitate advanced hydrodynamic vortex separation by reducing turbulence, lengthening the flow path to increase chamber residence time and introducing shear planes.

The internal components also ensure that the pollutant storage zones are isolated and protected from high flows that could cause pollutant re-entrainment or wash out.

Compared to devices that have poorly designed internal components, the Downstream Defender® captures and retains more of the annual pollutant load.

Watch a short video showing the Downstream Defender® components and operation at:

<http://www.hydro-int.com/en-gb/products/downstream-defender-0>



### Repeatable, Reliable Performance

The Downstream Defender® delivers high removal of pollutants through advanced, hydrodynamic separation across a wide range of flows. The device has a proven track record of tackling an assortment of pollutants including:

#### Fine particles



Greater than 80% removal of fine sand particles.

#### Gross Pollutants



100% of floatable debris, such as food wrappers, Styrofoam cups and drinks cartons removed in independent site trials.

#### Liquid and Sediment Bound Hydrocarbons



Greater than 50% removal of various forms of hydrocarbons, including free floating oils and polycyclic aromatic hydrocarbons (PAHs).

#### Sediment Bound Heavy Metals and Nutrients



As an efficient device for removal of fine sediment, the Downstream Defender® is also effective for removal of sediment bound pollutants.





## Design Data

### Downstream Defender®

#### Advanced Hydrodynamic Vortex Separator

### No Risk of Pollutant Wash Out

The Downstream Defender® has been specially designed to isolate the pollutant storage zones and is proven to prevent pollutant wash out. See Technical Abstract: The Importance of Pollutant Wash Out Protection.

### Sizing

The Downstream Defender® can be sized for different treatment goals and objectives.

For design purposes, the selected model's Treatment Flow Rate should be greater than or equal to the site's Water Quality Flow Rate.

The hydraulic capacity of the selected model should be considered with respect to the peak discharge flow rate from the site.

Model Diameter (m)	Treatment Flow Rate (l/s) <sup>a)</sup>	Hydraulic Capacity (l/s) <sup>b)</sup>	Oil Storage Capacity (l)	Sediment Storage Capacity (m <sup>3</sup> )
1.2	42	120	270	0.7
1.8	96	270	1350	1.7
2.55	192	542	2500	3.8
3.0	265	750	4650	4.4

#### Notes:

- a) Treatment flow rates based on >80% removal of US Silica Sand OK110 with no flow bypass. Sizing based on removal of finer or coarser sediment ranges or for free oil removal can be provided if required.
- b) Maximum flow rate that can pass through the chamber without surcharge to the upstream network.

Head loss at the treatment flow rate is typically less than 500 mm.

Table 1 - Downstream Defender® design information.

### Expert Design Service

Hydro's professional engineers are on hand to provide free support with the correct sizing and selection of the Downstream Defender® within each drainage design.

We can also provide estimated maintenance intervals, whole life cost estimates and predicted pollutant removal performance.

**Call the StormTrain® Hotline on: 01275 337955 or email [stormtrain@hydro-int.com](mailto:stormtrain@hydro-int.com)**

### Setting Out

The Downstream Defender® can accommodate a change in pipe direction to suit site specific requirements. Combined with the high rate internal bypass, this helps to avoid the need for additional manholes on site. Head loss across the chamber is kept to a minimum (see Table 1).

The inlet and outlet pipes should be sized in accordance with Table 2 (opposite), and a minimum of 90 degrees between inlet and outlet is required.

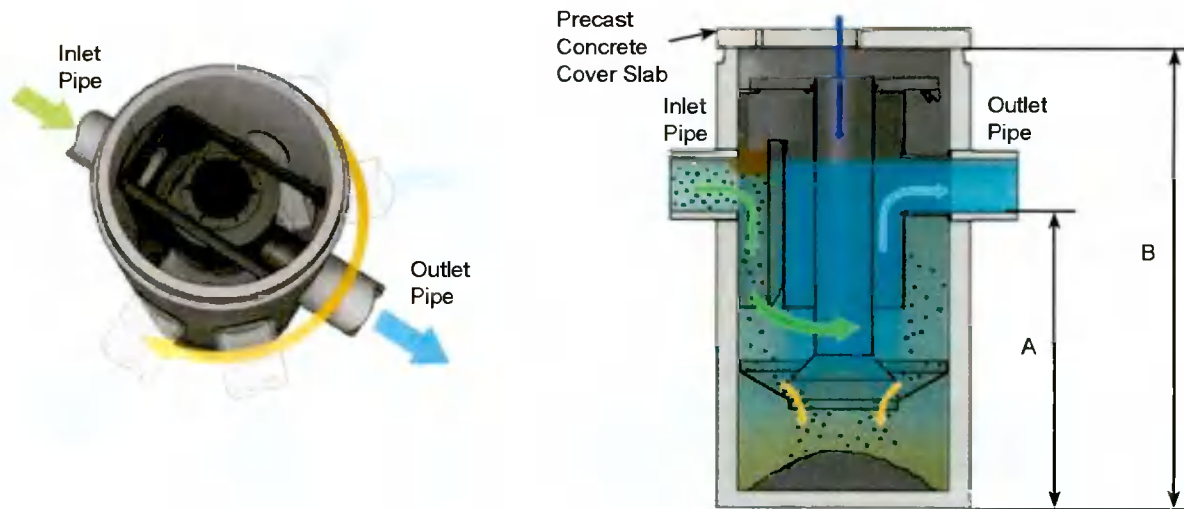
Inlet and outlet pipe connections are at the same invert level.

Additional manhole sections can be provided to extend the chamber to meet site cover and invert levels or provide additional pollutant storage where required.

# Design Data

## Downstream Defender®

### Advanced Hydrodynamic Vortex Separator



## Dimensions and Weights

General arrangement drawings of all units are available for download from:  
<http://www.hydro-int.com/en-gb/products/downstream-defender-0>

Unit	External Diameter of Unit (mm)	Inlet & Outlet Pipe Diameter (mm)	Depth (m)			Lift Weight (t)
			A	B	Component Depth <sup>a)</sup>	
<b>1.2 m Sealed Manhole System with HD Cover Slab</b>	1460	300	1.910	2.600	2.830	
HD Cover Slab <sup>b)</sup>					0.230	0.6
Base Section					0.825	1.5
Top Section					1.765	2.5
<b>1.8 m Sealed Manhole System with HD Cover Slab</b>	2160	450	2.510	3.800	4.050	
HD Cover Slab <sup>b)</sup>					0.290	1.4
Base Section					1.235	5.0
Top Section					2.485	8.0
<b>2.55 m System with HD Cover Slab</b>	2850	600	2.950	4.750	4.950	
HD Cover Slab <sup>b)</sup>					0.200	2.8
Base Section					1.750	8.0
Top Section					3.000	10.0
<b>3.0 m System with HD Cover Slab</b>	3350	750	3.125	5.000	5.200	
HD Cover Slab <sup>b)</sup>					0.200	4.6
Base Section					2.000	12.5
Top Section					3.000	14.0

**Notes:**  
a) Base and Top Section component depths are shown as the total height during transportation / before assembly on site. The total depth is the depth of the assembled unit.  
b) Cover slabs are heavy duty, suited for highways loading and are supplied with one or two access openings for maintenance.  
c) Inlets and outlets are supplied with cast-in holes only. No stub pipes are provided.

Dimensional Tolerances: Height  $\pm$  25 mm; Diameter  $\pm$  12 mm; Wall Thickness  $\pm$  10 mm

Table 2 - Downstream Defender® dimensions and weights.

## Design Data

# Downstream Defender®

## Advanced Hydrodynamic Vortex Separator

### Easy to Install

The Downstream Defender® is typically delivered to site as a precast concrete manhole with internal components already installed. Installation is therefore similar to any other manhole installation on site. Full installation guidelines are available.

Lightweight High Density Polyethylene (HDPE) chambers can be provided where installation of a concrete manhole is not practical.

### Easy to Maintain

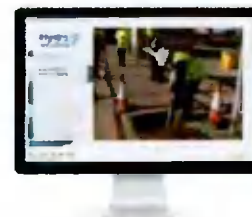
Maintenance of the Downstream Defender® is simple, safe and cost-effective. Maintenance is carried out from the surface, using a standard vacuum tanker and personnel are not required to enter the device.

With a large capacity to store sediments and oils (see Table 1), and with a proven ability to prevent wash out, maintenance intervals can be years rather than months - depending on site conditions.

Additional pollutant storage can be built into the chamber to extend maintenance intervals if required.

Watch a short video showing the Downstream Defender® maintenance at:

<http://www.hydro-int.com/en-gb/products/downstream-defender-0>



## Downstream Defender® Technical Guidance



Case Studies



Installation and Maintenance Guidelines



General Arrangement Drawings

## The Hydro StormTrain® Series of Surface Water Treatment Devices

The Downstream Defender® is one of the Hydro StormTrain® Series of surface water treatment devices. Each device delivers proven, measurable and repeatable surface water treatment performance. Each can be used independently to meet the specific needs of a site or combined to form a management train. They can be used alongside natural SuDS features to protect, enable or enhance them.



First Defense®  
Vortex Separator



Downstream Defender®  
Advanced Hydrodynamic  
Vortex Separator



Up-Flo™ Filter  
Fluidised Bed Up Flow  
Filtration System



Hydro Biofilter™  
Biofiltration System

# Technical Abstract: Downstream Defender® & First Defense® EN858-1 Oil Removal Performance

27/10/2017

## Introduction

Oil or fuel leaks and spills from trafficked areas, such as alongside highways, at commercial or industrial car parks, or residential homes, pose significant hazards to the environment. The capability to contain these spills is an important performance criterion for stormwater treatment devices, preventing toxic substances and high levels of COD and TOC entering the environment.

To verify the capability of the Downstream Defender® and First Defense® to protect water bodies from hazardous spills, Hydro International have used the BS EN858-1:2002 (Separator systems for light liquids) test protocol to provide appropriate sizing criteria.

## Downstream Defender® & First Defense®

The Downstream Defender and First Defense are advanced vortex separators designed to utilize the principles of swirl-enhanced separation to remove TSS, trash and hydrocarbons from stormwater runoff. Flow modifying internal components enhance separation and provide distinct pollutant capture and storage zones.

## Laboratory Testing Procedure

First Defense and Downstream Defender units were tested according to BS EN 858-1:2002 to assess their ability to capture oil for spill containment scenarios. The EN858-1 test procedure requires that diesel oil be dosed at a rate of 0.005 litres per litre of water to assess system capture performance. Separators are categorised into two classes, Classes I and II, depending on the average outlet oil concentration. The passing requirements for Class I and II are shown in the following table:

Table 1: EN858-1:2002 discharge limits

Class	Maximum permissible content of residual oil <sup>a</sup> mg/l
I	5.0
II	100

In addition to the average outlet concentration limits, a maximum is also imposed, where "no individual sample shall have a higher value than 10mg/l for class I or 120mg/l for class II.

Class I separators are usually applied to treat discharges to surface water bodies or drainage and Class II separators for discharges to foul water sewers.

## Removal Performance and Unit Sizing

Testing of the separators according to the EN 858-1 protocol indicated it was possible for both the First Defense and Downstream Defender units to meet Class I and Class II effluent requirements. Small-scale 600mm diameter units were tested to limit environmental hazards associated with the test procedure. Scaling was performed according to Froude's law to predict the maximum flow-rates at which 1.2, 1.8, 2.55 and 3.0m diameter units would meet the Class I or Class II removal criteria. Test results for the Downstream Defender are shown in Figure 1. The flow-rates satisfying the Class I/II removal criteria for both the Downstream Defender and First Defense are listed in Table 2.

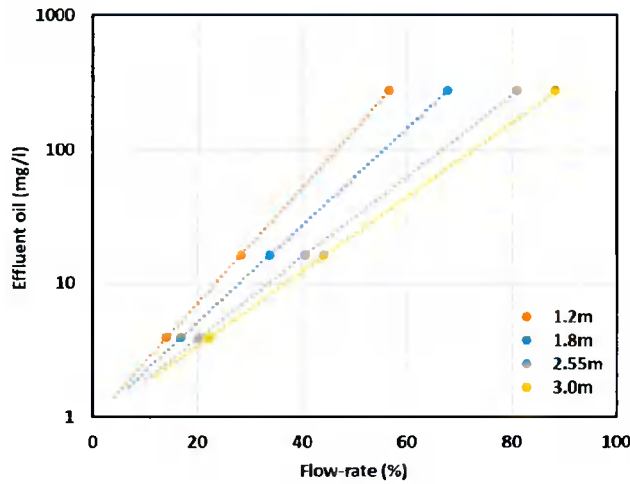


Figure 1: Effluent oil concentration from Downstream Defender separators in accordance to EN858-1:2002.

Table 2: Flow-rates meeting Class I/II removal criteria

Unit Size (m)	Downstream Defender <sup>®</sup>			First Defense <sup>®</sup>		
	Treatment Flow-rate (l/s)	EN858-1 Class I Flow-rate (l/s)	EN858-1 Class II Flow-rate (l/s)	Treatment Flow-rate (l/s)	EN858-1 Class I Flow-rate (l/s)	EN858-1 Class II Flow-rate (l/s)
1.2	30	5	14	29	4	TBC
1.8	69	14	38	65	12	TBC
2.55	138	33	92	-	-	-
3.0	190	49	138	-	-	-

**Usage**

Separators may be sized in two ways, full-retention or bypass. Full retention devices must be able to treat the peak flow-rate predicted for the unit. A bypass device may be sized to only treat a proportion of the predicted peak flow-rate, the remainder being bypassed. Bypass units are typically used where when it is considered an acceptable risk not to provide full treatment for high flows, e.g. where only small spillages can occur, and the risk of spillage is small. It is normally acceptable to consider bypass sizing protocols for SUDS scenarios, where 10% of the peak flow is an acceptable treatment target.

The First Defense and Downstream Defender are effective oil spill containment devices and meet BS EN 858-1:2002 Class I and II removal targets at the specified flow-rates. It should be noted these systems are not considered oil separators according to BS/DIN EN 858-1 and must NOT be used in applications where full certification is required.

**Maintenance**

In brief, where oil discharge is a potential hazard, EN858-1 recommends each separator should be inspected at least every six months to determine to levels of oil and sediment. A log of these inspections should be kept. If emptying is necessary, this should be carried out by a responsible contractor using the required EA certificates (notifiable waste) where required.

## C. Background Reports Summary

The following sections give an overview of each report undertaken relating to the **Upgrade of the Tobermaclugg Stream** and the ASDZ from 2005 to 2010.

### C.1 Summary of 2005 Report

The initial **Report of 2005** "*Assessment of the Tobermaclugg Stream Upgrade to the River Liffey*".

- The report's main focus was to examine options for the **Tobermaclugg Stream** as part of the ASDZ, since this passes through the ASDZ.
- The **Backstown Stream**, which converges with the Tobermaclugg Stream on Tubber Lane Road, was also included in the study although no development was planned for its catchments. (However, it was subsequently noted that only part of the catchment was included due to an initial oversight.)
- The report determined
  - i. the proposed future drainage of the ASDZ lands and
  - ii. the need to alleviate previous flooding issues on Tubber Lane Road.

The strategic surface water model developed for the contributing catchments was based on available contour plans, OS mapping and aerial photography.

- The culvert constructed for the **Tobermaclugg Surface Water Drainage Scheme** conveys the **Tobermaclugg Stream** flows away from Tubber Lane Road within the north-western boundary of the ASDZ and is designed to convey surface water runoff from the developed ASDZ lands via a 2.1 / 2,4m  $\varnothing$  pipe system down Tubber Lane Road and then through Lucan Golf Course, where the flows re-join the Backstown Stream below the Golf Course at Millstream Road. By diverting the Tobermaclugg Stream and surface water run off flows, the volume of surface water into the old ditch/stream onto Tubber Lane Road has been reduced considerably

as the Backstown Stream is now the only watercourse contributing to the stream flow at the old confluence point.

1. This report provides a detailed analysis of a number of alternative design scenarios for the future storm water system of the ASDZ lands.
2. The analysis was carried out with the use of hydraulic models constructed using *InfoWorks CS*, in line with the methodologies used in the Greater Dublin Strategic Drainage Study (GSDSDS).
3. A model of the existing Tobermaclugg-Backstown catchment was constructed with the use of a topographical survey, the existing drainage records etc. The total catchment is 612 hectares in area. A critical duration of 540 minutes for the catchment was identified. The systems were analysed for the 30 year and 100-year ARI events.
4. A number of culverts have been identified, viz: the culvert under the Grand Canal, culvert under railway immediately upstream of ASDZ lands, culvert at Millstream Road and a culvert under the N4.
5. No information was available on the Grand Canal culvert and it is assumed to have adequate capacity to pass forward all flows. The railway culvert is a significant throttle on the system and furthermore can result in flooding of lands upstream of the culvert. The remaining significant culverts are of sufficient capacity up to the 100 year ARI.
6. Sensitivity analysis off the situation of the railway culvert demonstrates that the siltation does significantly reduce flows through the culvert and causes further flooding of lands upstream of the culvert. It is recommended that a regular programme of maintaining full flow in this culvert is carried out i.e. removal of silt, vegetation etc.
7. The analysis takes into account climate change, allowing an additional 10% (20% mentioned as OPW requirement for Major Culverts) increase in rainfall intensity.
8. The impact of the River Liffey has also been examined for all the alternative design scenarios. Whilst in extreme flood the river does surcharge the N4 culvert it does not impact on the catchment further upstream.
9. The runoff from the development lands in time of extreme rainfall is found to be insignificant in comparison to flows in the River Liffey. Furthermore any peak response in the Tobermaclugg-Backstown catchment will have reached the River Liffey much earlier than the peak response of the river to the same event.
10. The model of the existing system predicts flooding at a number of locations throughout the catchment including upstream of the railway culvert and Tober Lane and the Golf Course Lands. This coincides with known instances of flooding.
11. Four design scenarios have been developed, viz:

Scenario 1A: Culverting of Tobermaclugg-Backstown catchment to Golf Course and stream improvement works from Golf Course to River Liffey.

Scenario 1B: Per Scenario 1A with upgrading of the railway culvert.

Scenario 2A: Per 1A with the northeast catchment draining into the Tobermaclugg-Backstown catchment.

Scenario 2B: Per Scenario 2A, with the upgrading of the railway culvert.

12. For Scenario 1A, the stream is culverted downstream of the railway culvert into a circular shaped culvert, to an open channel through the Golf Course lands. These culverts and channels have been sized for both the 30 year and 100-year ARI events.
13. Scenario 1B for the 30-year design requires an additional 900 diameter culvert under the railway. For the 100-year design 2 No. 1050 diameter culverts are required in addition to the existing culvert. Scenario 1B requires larger diameter culverts of the Tobermaclugg Stream in comparison to Scenario 1A. The dimensions of the proposed open channel are the same for both scenarios.
14. For Scenario 2A culverting of the stream is generally per Scenario 1A with some upsizing of the circular shaped culvert required to take account of additional flows from the North-East catchment.
15. For Scenario 2B the additional culverting under the railway culvert is per Scenario 1B viz: 30-year design of 1 no. 900 diameter culvert; 100-year design of 2 no. 1050 diameter culvert in addition to the existing arch culvert.
16. The difference between Scenario 2A and 2B is the upsizing of the circular shaped culverts generally by one size, with no difference in the dimensions of the proposed open channel cross section.
17. The culverting along Tubber Lane Road is designed to replace all existing small culverts and open channels which are prone to flooding. The proposed culvert along Tubber Lane Road is designed not to cause flooding along Tubber Lane Road.
18. Comparing Scenario 1 & 2 shows little difference in a 30-year design, with the only difference being the upgrade of the diameter of the circular shaped culvert downstream of the discharge point of the North-East catchment into the Tobermaclugg-Backstown catchment. For the 100 year design the difference between Scenarios 1 and 2 is again only in the sizing of the circular shaped culverts, with Scenario 2 requiring slightly larger circular shaped culverts.
19. There is an option to provide a low flow channel at ground level and above the proposed culverting of the Tobermaclugg-Backstown stream. These channels would be designed to



convey base flows through the development lands. The underground culverts would convey the additional storm flows.

20. The existing railway culvert, at the upstream end of the ASDZ lands has been identified as a significant throttle on flows to the downstream catchment. There is the possibility that in the future this culvert could be upgraded and in all likelihood this upgrade would be to the 100-year ARI design.

It is therefore recommended that the proposed Tobermaclugg Stream culvert be designed to accommodate flows for the 100-year ARI with the railway culvert upgraded to accommodate the 100-year ARI. Therefore, Alternative B should be adopted, whether it is Scenario 1 or Scenario 2.

Scenario 1 B has been designed to convey flows from the Tobermaclugg-Backstown catchment, with **Scenario 2B designed to accommodate flows from the Tobermaclugg-Backstown catchment and the North-East catchment.**

## C.2 Summary of May 2006 Report

The **Addendum Report of May 2006 "Tobermaclugg Stream Upgrade"** progressed matters with the proposed addition of a 5,000 m<sup>3</sup> attenuation pond at Millstream Road. This was included, following a design criteria change which restricted any storm flows being allowed to spill onto the old stream ditch or Tubber Lane Road at the Tobermaclugg Foul Pumping Station.

- The hydraulic results of the various critical storm durations were assessed for the various return periods in line with the GSDSDS, whilst making allowance for climate change (10%) for each storm event and a 4% reduction in rainfall for the size of the catchment area. A 30-minute 100-year ARI duration storm with a winter profile was determined as critical for the system downstream of the Tobermaclugg Pumping Station. Therefore the following was implemented: -
  - i. Limit the flow in the culvert to 12m<sup>3</sup>/s at the Pump Station
  - ii. Channel the existing Tobermaclugg Stream at the Pump Station with a 1m x 1.5m concrete channel & screen.
  - iii. Construct an emergency overflow from the Tobermaclugg Stream into the stormwater culvert at the end of the concrete channel

- iv. Pipe the Tobermaclugg Stream from the end of the channel to the existing Tobermaclugg Stream along Tubber Lane Road
- v. Construct a 2.25m wide x 1.5m high stormwater culvert between the Pumping Station and Tubber Lane Road
- vi. Construct a 2.6m wide x 1.5m high stormwater culvert between the Tubber Lane Road and its discharge point just before the Mill Stream Culvert
- vii. Upgrade the Backstown Stream crossing of Tubber Lane Road to a 900mm  $\emptyset$  pipe
- viii. Remove the existing southern connection between the Tobermaclugg Stream and the Backstown Stream
- ix. Restore the original profiles of the Backstown Stream and Tobermaclugg Stream
- x. Create a 5 000m<sup>3</sup> attenuation pond between the Golf Course and the Millstream Road culvert
- xi. Construct a 450mm  $\emptyset$  pipe from the discharge point of the stormwater culvert into the Liffey to prevent pollution of the Tobermaclugg Stream in case of discharge of foul water from the Tobermaclugg Pumping Station

### C.3 Summary of October 2006 Report

In October 2006 a further **Addendum Report** was issued following: -

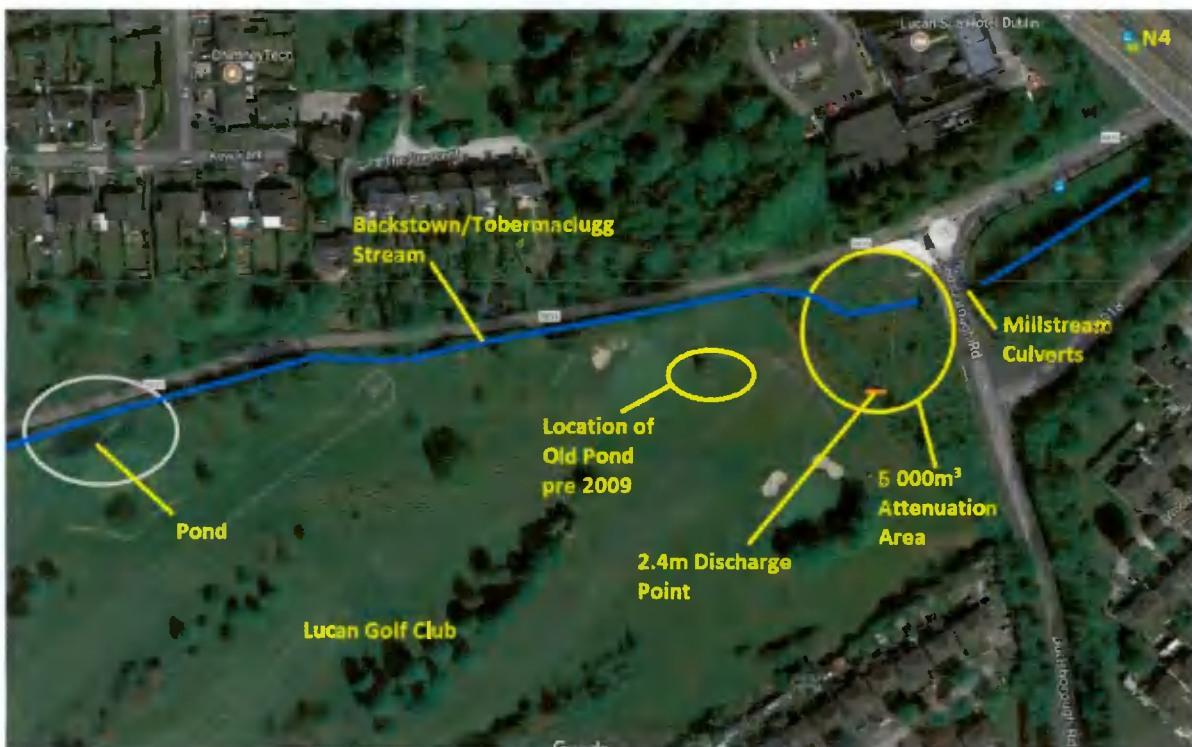
- checks of the drainage mechanism within the Lucan Golf Course,
- check of the Composition/Dimensions of the N4 Culvert and
- the requirements from SDCC not to discharge stormwater to the storage tanks at the Tobermaclugg Pumping Station.

This led to a re-examination of the hydraulics of the Tobermaclugg Stream.

At the time of the original survey, the Tobermaclugg Stream had a low flow, and access to survey all relevant components was easily achieved. An assessment in September 2006 initiated alterations to the model, making the following adjustments to the in-situ components:

- i. Revision of the vegetation coefficients of the stream between the Golf Course and the N4 Culvert
- ii. Dimensions of the composite N4 Culvert – The shape was initially assumed as being uniform, based on the entrance and exit opes, but was in fact as follows: -
  1. 1.7m (h) x 2.0m (w) for 78m with an approximate 30° bend left after approximately 58m from the inlet
  2. The culvert then widens to accommodate the original stone arch structure 4.0m (w) x 2.0m (h) and approximately 15m long
  3. The Stone arch flows to 3.6m (w) x 2.0m (h) concrete box culvert for approximate 15m with the façade on the downstream culvert outlet replicating the stone arch structure.
- iii. The flow path and drainage mechanism for the Lucan Golf Course.
  1. The flow through the golf course passes through a water feature (pond) on the eastern boundary closest to the Millstream culvert. The pond's water level is controlled by a buried 150m ø pipe, which then discharges to a ditch over the boundary of the golf course and flowing to the Tobermaclugg Stream via a 750mm ø pipe. During storm conditions the 150ø has insufficient capacity to carry the flows and the pond is overtopped. Water flows overland to the 750ø pipe. The capacity of the 750ø pipe exceeds the predicted flow

from the golf course and assuming no influence from the Tobermaclugg Stream, this level dictates the localised flooding of the golf course. (This pond has since been removed – however there is a second pond approximately 240m upstream of the 5 000 m<sup>3</sup> attenuation pond. – See below current 2017 layout of northern portion of the Lucan Golf Course.)



iv. Therefore, the following additional works were undertaken:

1. Replacing of the existing Millstream Road Culvert with twin 2.1m box culverts, partially buried 300mm below the existing streambed to preserve existing salmonoid habitat

2. Excavation of an attenuation pond (to maximise possible storage volume within the property boundaries) immediately upstream of the Millstream Road Culvert
  3. Construction of a bund along the left overbank of the Tobermaclugg Stream along the Celbridge Road between the Millstream culvert and the N4 culvert assuming a 500mm freeboard.
  4. Removal of the 750mm  $\emptyset$  pipe channelling flows from the Lucan Golf Course, with flows to fall directly into the proposed Millstream Road attenuation pond. (This pond has since been removed.)
- v. The results of the adjustments to the model indicate that the critical duration storm is now a 45min winter storm with the source of the primary peak determined as the proposed urban development. A secondary peak from the slow release vegetated regions upstream, is estimated to have a critical storm duration of approximately 720min. The secondary peak is not responsible for the flood water maxima at the junction of the proposed Lucan Golf Course Culvert and the Tobermaclugg Stream, but was used for runoff analysis from the undeveloped areas within the catchment. The failure mechanism at the junction of the proposed Lucan Golf Course culvert and the Tobermaclugg Stream is the short "flash" storm event whereby runoff from the proposed development upstream builds up behind the existing Millstream and N4 culverts. Analysis has included options of storage (Option 1) and construction of new culverts (Option 2) to allow passage of flow directly to the Liffey River as discussed in the respective sections in the report.
- vi. Under the upgrade works undertaken, it was predicted that localised flooding would occur on the golf course under 1 : 30 year ARI return storms and above. However, this will occur for a short duration only and the golf course is unlikely to be open under such extreme events. Negotiations

took place with the Lucan Golf Course and SDCC prior to undertaking the recommended upgrades.

#### C.4 Summary of October 2008 Report

This report dealt with the final detail of Tobermaclugg Stream Upgrade, whilst considering the requirements of the surface water runoff from ASDZ, and examined key issues, such as the Design Criteria and Proposed Scheme for implementation. The final route for the 2.4m ø storm sewer was developed in consultation with the Lucan Golf Club.

The project constructed later in 2008 comprised of the following:

- i) Abandoning of the existing cross connection between Backstown Stream and Tobermaclugg Stream on the southern end of Tubber Lane Road.
- ii) Installation of a 885m long 2.4 ø concrete pipe from Tobermaclugg Pumping Station, through Lucan Golf Course and to the Mill Stream culvert attenuation pond.
- iii) Control of maximum flows in the Tobermaclugg Stream.
- iv) Upgrading of Mill Stream culvert to twin box sections 2m x 2m. (Actual installed 2.1m)
- v) Installation of 320m of 450mm ø emergency overflow sewer from termination of stormwater culvert to River Liffey. (This would operate in the unlikely event of a mechanical failure at the Tobermaclugg Pumping Station).
- vi) Constructing a bund wall to the attenuation area between Celbridge Road and Old Millstream Road on existing South Dublin County Council lands.
- vii) Constructing a 5000m<sup>3</sup> attenuation pond between Lucan Golf Course and Millstream Road and culvert and the fencing/landscaping to attenuation areas.

The works were implemented via Part 8 Planning through "Chartridge Development".

## C.5 Summary of March 2010 Report

In **March 2010** a further report titled “**Review of Flooding Events on Tubber Lane Road**” was prepared by WYG following flooding in November and December of 2009 of the public road (Tubber Lane Road), which passes through Lucan Golf Course.

- a) The factors, which combined to contribute to this flooding and a proposed solution, were the subject of this report.
  - i) A full reassessment of the contributing areas was undertaken – during this process it was noted that the **Backstown Stream** consists of a 316 ha catchment or approximately 46% of the contributing catchment area.
  - ii) This catchment was initially modelled strategically based on an area of 126 ha. (There is no clear reason why the catchment area was restricted to only 126 ha) Observations during storm events in November and December 2009 lead to a re-examination of this catchment. Significant flows, causing flooding of the road, were noted where the stream crosses Tubber Lane Road at Location B, as well as at Location A (Figure 1.0), where the stream passes through Lucan Golf Club. The stream emanates adjacent to the Grand Canal and contributes an additional area of approximately 290 ha to the catchment as shown in Figure 2.0.
- The combined Tobermaclugg – Backstown Stream catchment equates to a total of 902 ha (i.e 486 ha + 416 ha = 902 ha).

### *Design Review – 2010*

The following sub-sections give an overview of the components that were reassessed following the flooding of Tubber Lane Road in November/December 2009.

#### A Catchment Survey

Following recent observations of the catchment as described in the report, and to confirm its potentially greater extent, a surveyor was procured to resurvey the Backstown Stream



and its catchment. The stream profile was surveyed at regular intervals along its length together with all structures encountered. The survey included 11 No sections through the stream channel and 11 No. hydraulic structures.

Ordnance Survey Ireland (OSI) LiDAR data, which provides topographical information, was also sourced to review the catchments extent.

## B Tubber Lane Road Pipes

The Backstown Stream is conveyed via a ditch system before it merges with the old Tobermaclugg Stream ditch/pipe crossing at Tubber Lane Road. The stream then flows along the western edge along Tubber Lane Road via an open ditch for approximately 190m. According to records, it then enters a 900mm  $\varnothing$  concrete culvert. This then bifurcates into 600mm  $\varnothing$  and 750mm  $\varnothing$  culverts, with the latter crossing the public road into the Golf course ditch. The 600mm  $\varnothing$  culvert further bifurcates into twin 300mm  $\varnothing$  and simple 300mm  $\varnothing$  pipes which cross the Tubber Lane Road and join with the flows from the 750mm  $\varnothing$  culvert in an open channel. Accordingly, the combined free flowing capacity of the network is 810 l/s, which is equivalent to a notional 900mm culvert.

The layout of the existing pipelines crossing the road is shown on drawing 880/02/123 (Appendix B).

## C Other key culverts and recent works

In addition to those highlighted by the survey, a number of other significant structures were recorded throughout the Backstown catchment during a site visit on 3<sup>rd</sup> December 2009. Structures of note include recently constructed Irish Rail culverts beneath new rail lines, which include a combination of a 1,000mm x 2,000mm and 1,400mm  $\varnothing$  concrete structures.

A new 900mm  $\varnothing$  concrete culvert has been recently installed at Location B at the entrance to the Department of Agriculture Lands.

The open channels either side of Tubber Lane Road at Location A (Figure 1.0) have been cleared and pipes crossing the road have been unblocked.

These works alter the behaviour of the catchment during storm events by reducing upstream attenuation.

South Dublin County Council cleared the channels and pipes that traverse the entrances to the dwellings on the southern side of Tubber Lane Road. The Tobermaclugg Stream will travel through these channels and pipes and will join with the Backstown Stream north of Tubber Lane. As described in this report, Tobermaclugg Stream flows over approximately 100  $\ell/s$  are diverted into the 2.1m-2.4m  $\varnothing$  culvert upstream. A flow is maintained in the stream for environmental reasons. Therefore, although this measure will reduce flows crossing the road at Location A by circa 100  $\ell/s$ , its impact on storm flow hydraulics and culvert sizing will not be significant.

#### *Storm Events of November / December 2009*

Weather stations throughout the country had record falls of rain for the month of November 2009. At Casement Aerodrome 225% of the normal monthly rainfall occurred. The rainfall event which occurred on the 29th November 2009 produced 36mm of rain over a 20-hr period and was categorised as a 2 year ARI event. It should be noted that the 2-year ARI event represents approximately 34% of the 100year ARI or 32% of the 200 year ARI event rainfall.

The occurrence of several major rainfall events in succession during the antecedent period in November contributed to high stream levels and saturation of the surrounding catchment. Met Eireann reported that rain or showers were recorded almost every day in November. The time of concentration of the catchment was significantly reduced and therefore the shorter duration events had a major impact on stream flows. The storm event of 29th November and the Met Eireann monthly report are included in Appendix A.

On 29th December 2009 a further flooding incident occurred during which Met Eireann recorded over 40mm of rain at Casement Airport.

# UK and Ireland Office Locations



