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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Comments

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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^3 attenuation pond next to the Millstream Road**

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 10th 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*

2.5.10 The remainder of the South-East Catchment compromises 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.

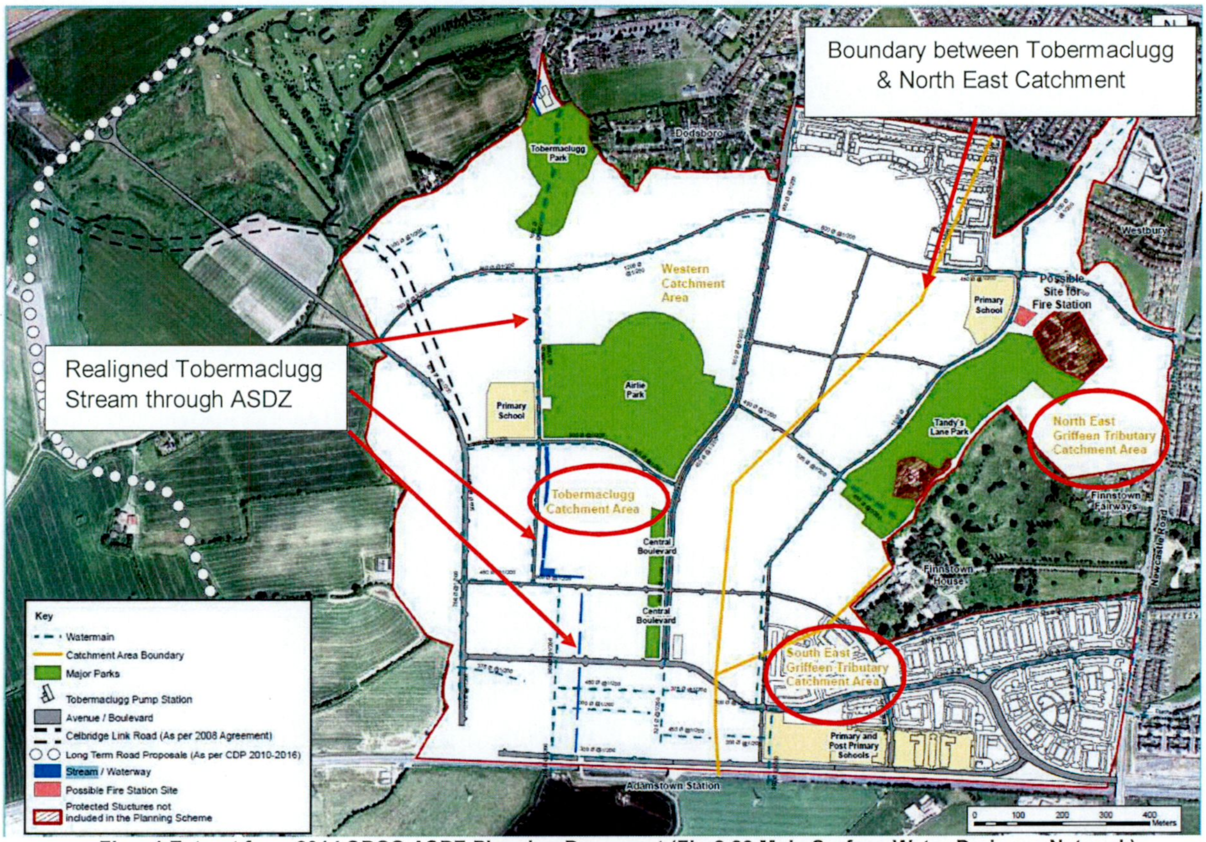


Fig x.1 Extract from 2014 SDCC ASDZ Planning Document (Fig 2.26 Main Surface Water Drainage Network)

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)"***

3.3 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 5000m³ 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.

4.2 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.

The Backstown Stream converges with the Tobermaclugg 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 ø 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 Tobermaclugg-(and Backstown) Stream sub-catchment.

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 (TOBERMACLUGG/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)

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.

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^3 / s)	100 Year ARI Peak Flow (m^3 / 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^3 / s
Culvert Under Millstream Road	11.00 m^3 / s (increased to 18.38m^3/s with Twin 2.1 Culverts)
Culvert Under N4 National Primary Road	26.88 m^3 / s upstream and 42.61 m^3 / s downstream

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

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/Dodsbourgh 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.

- **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 GDSDS, 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 ø culverts past the Tobermaclugg PS through the Lucan

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

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^3/s at peak for the 30-year ARI.

c) The peak flow increases for the 100-year ARI by some 0.53m^3/s and 0.87m^3/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,**

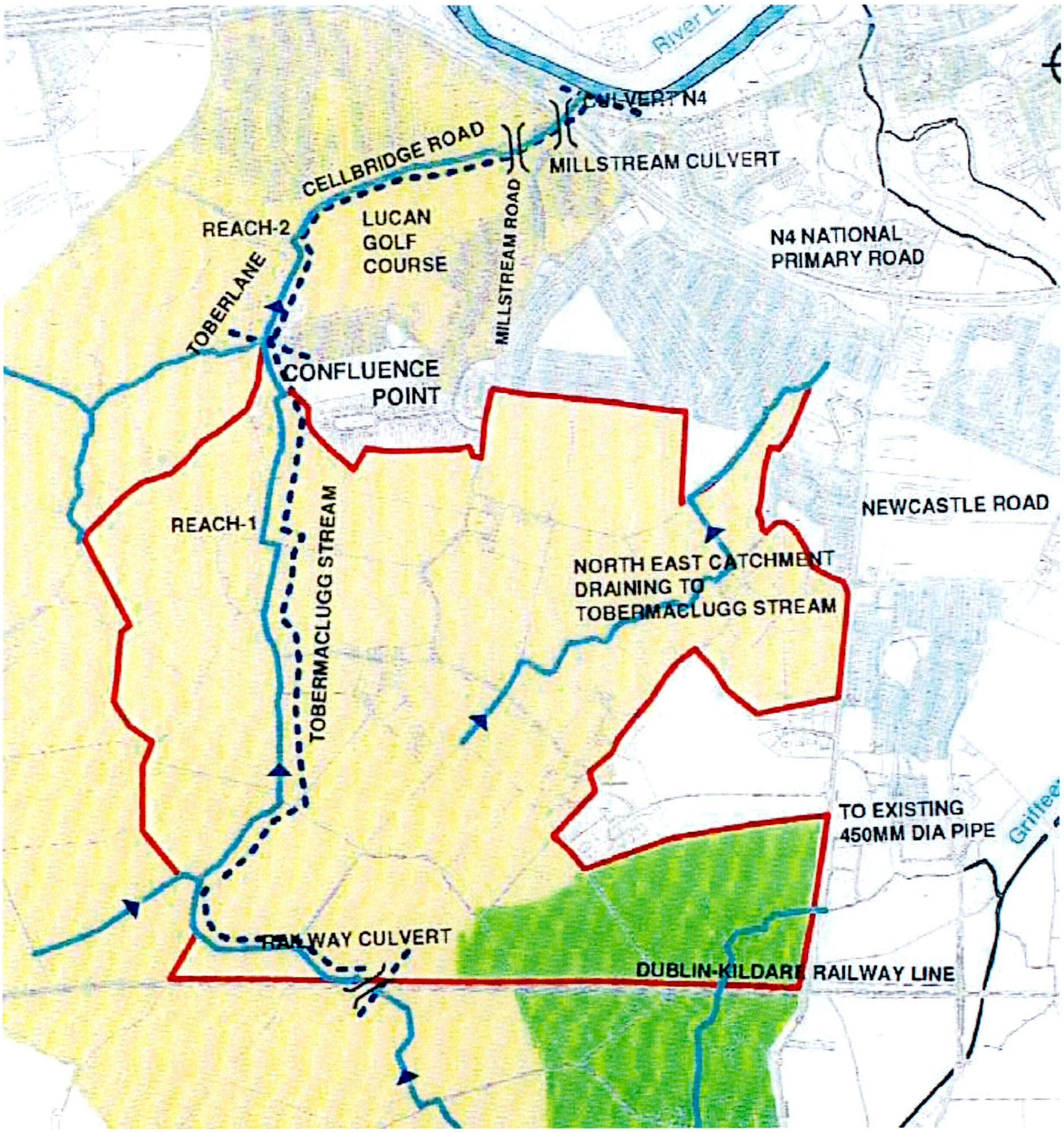


Figure E - Reflecting the Reach 1 & 2

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.

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 ø culvert for both scenarios; (A 1500ø 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 ø and 1 no. 1800 mm ø culvert**; (in the detailed design process a 2.1m ø 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 ø and 1 no. 1800 mm ø culvert followed by 631 metres of twin 1800 mm ø culverts. (During detailed design and consultation with SDCC, 2.4mø 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 ½ m freeboard).

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 bunded 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 12m³/s to prevent flooding of the Lucan Golf Couse

i) The incorporation of a 5000m³ 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 4m³/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 (GDSDS) 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.

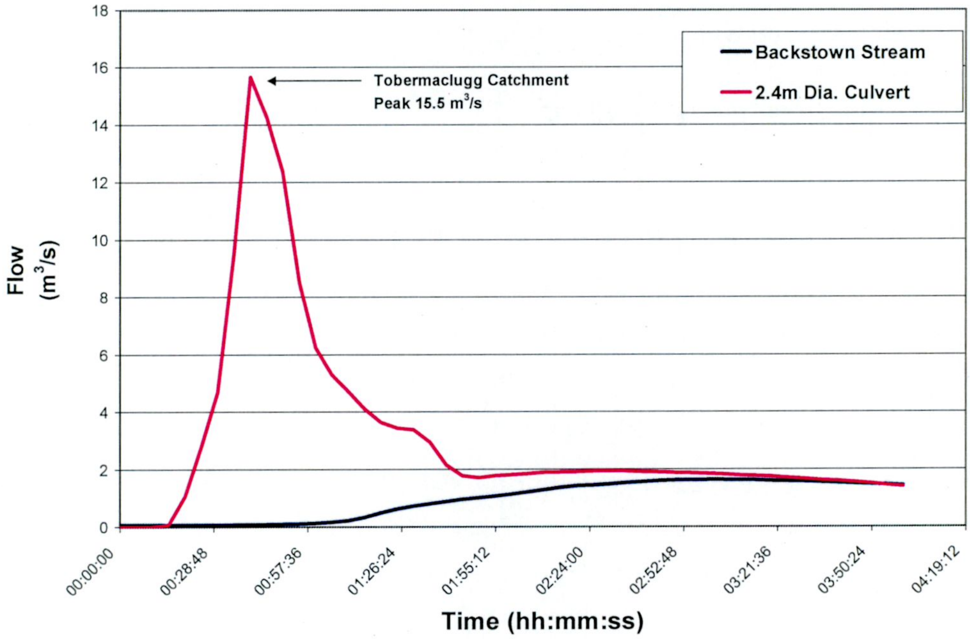


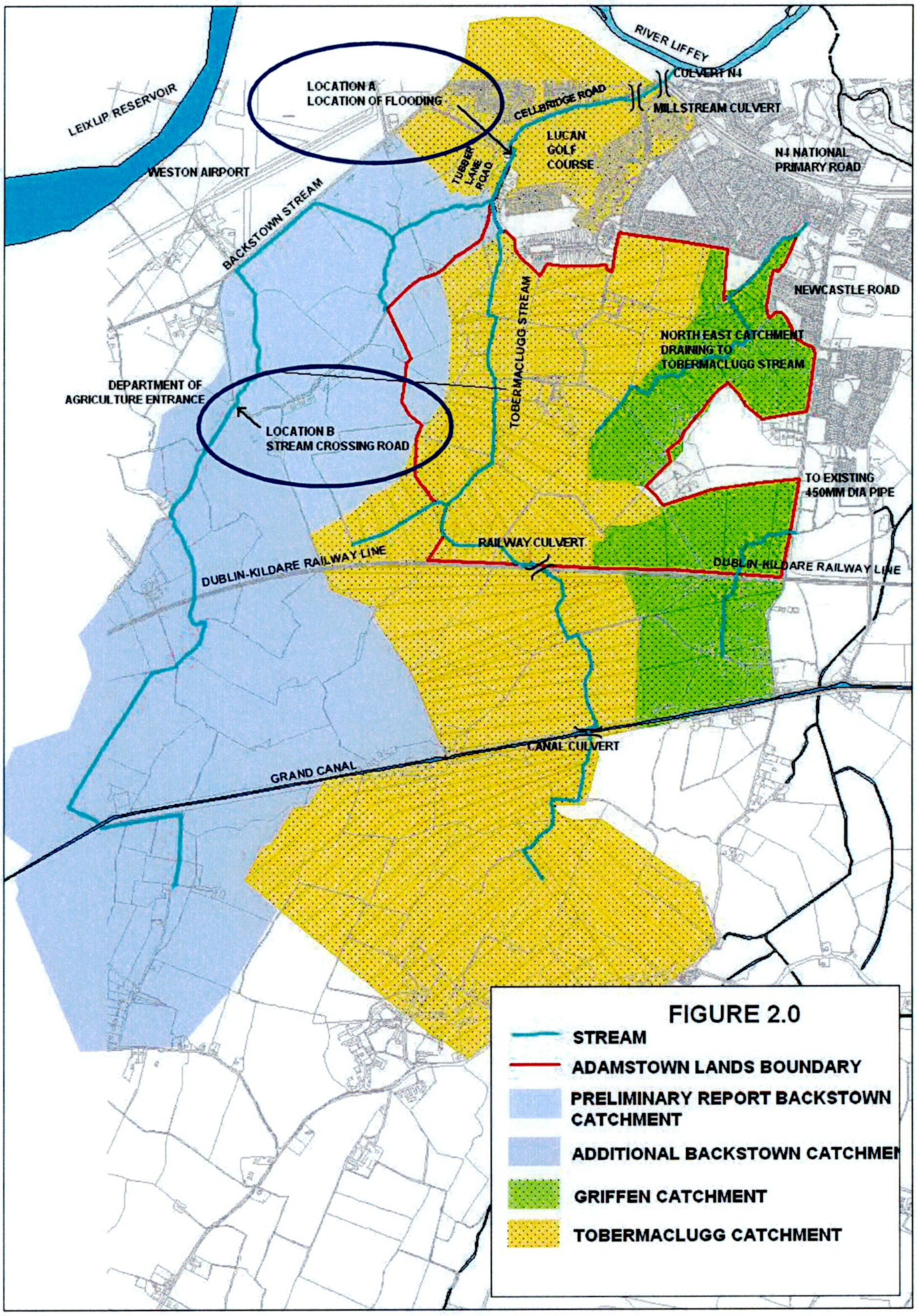
Figure 5.5 Catchment Storm Profiles

When examining the attenuation pond, it should be noted that a new 750m ø 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.

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 ø 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.



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.

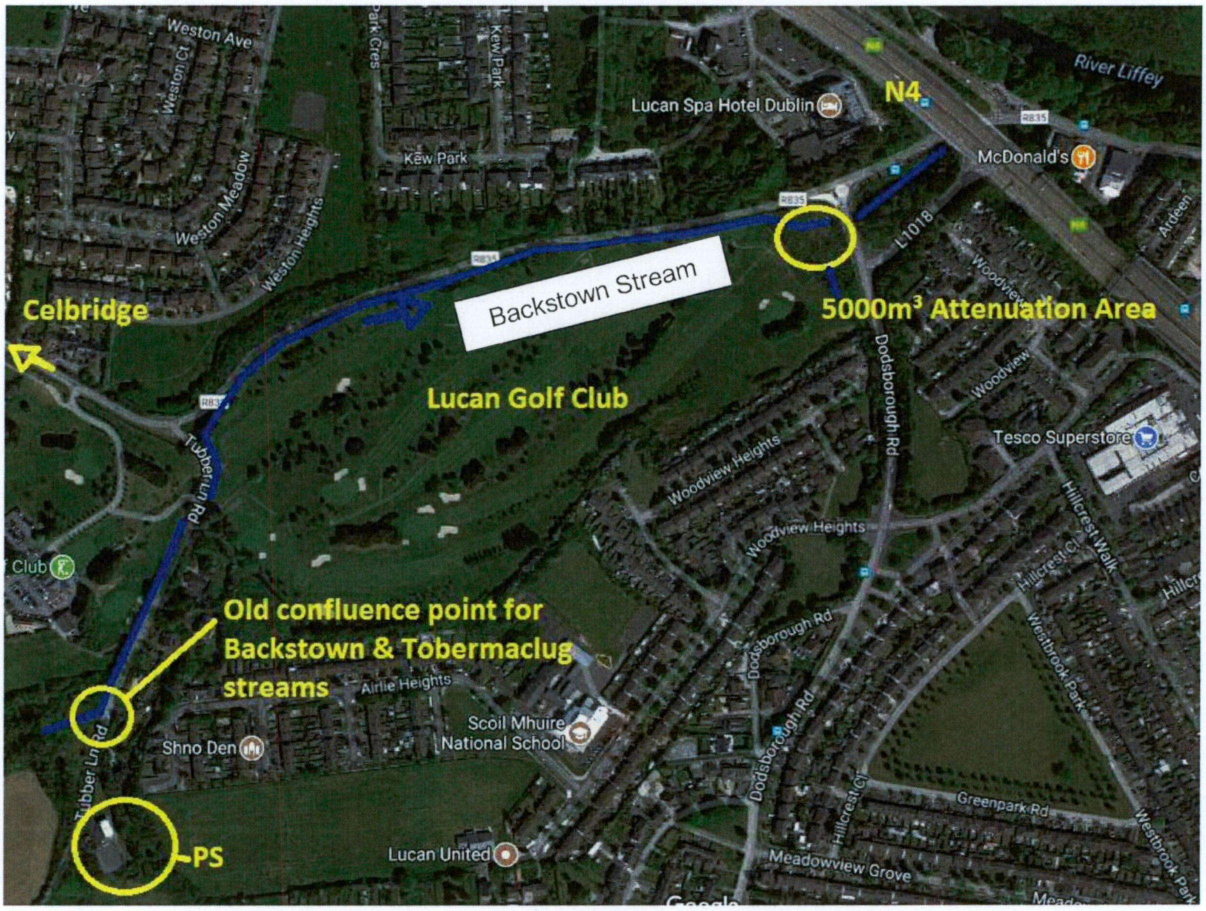


Fig A2 – Location of Backstown Stream and old Confluence Point with Tobermaclugg Stream

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).

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.

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 ø pipe culvert, was breached during the flooding event of 29th 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 29th Nov '09 and this rectified the breach by redirecting flows into the 2.1m / 2.4m ø culvert system. (This bund continues to control the stream flow well, as was demonstrated in the heavy rainfall events of the 29th/30th 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.)

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.

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 ø surface water pipe with a 450ø 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 ½ 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 ø pipe has been installed through the Lucan Golf Course to its discharge point at the Millstream Culvert
ix) A 2.1m ø 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 ø 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 900ø pipe to a 2.4 x 0.8 box culvert
xii) Low flow channels (100 ℓ/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 5000m³ 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.

Appendices

B. Downstream Defenders

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) a)	Hydraulic Capacity (l/s) b)	Oil Storage Capacity (l)	Sediment Storage Capacity (m^3)
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

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

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.

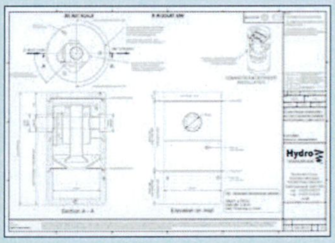
Watch a short video showing the Downstream Defender® maintenance at:

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

Downstream Defender® Technical Guidance

Case Studies

Installation and Maintenance Guidelines

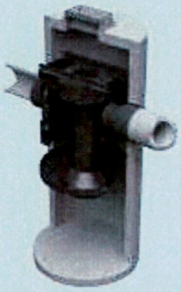


General Arrangement Drawings

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

Hydro International
Shearwater House, Clevedon Hall Estate, Victoria Road, Clevedon, BS21 7RD

The Hydro StormTrain® Series
StormTrain® Hotline: 01275 337955
stormtrain@hydro-int.com

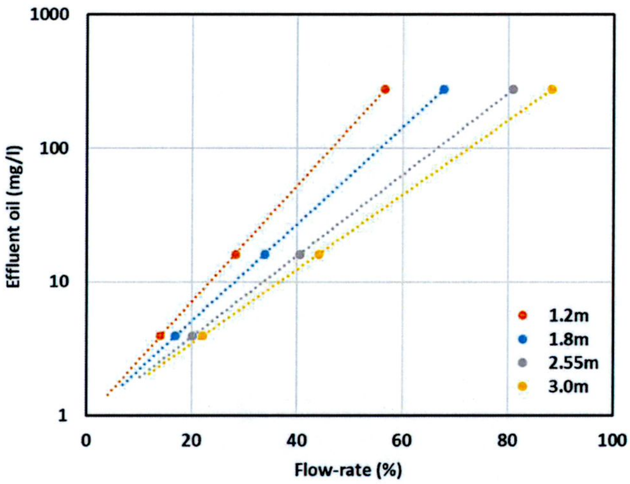


Figure 1: Effluent oil concentration from Downstream Defender separators in accordance to EN858-1:2002.

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

Unit Size (m)	Downstream Defender®			First Defense®		
	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.

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 (GDSDS).
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:

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^3 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 GDSDS, 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^3/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

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

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 ø 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

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 $5000m^3$ 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”.

and its catchment. The stream profile was surveyed at regular intervals along its length together with all structures encountered. The survey included 11 № sections through the stream channel and 11 №. 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 ø concrete culvert. This then bifurcates into 600mm ø and 750mm ø culverts, with the latter crossing the public road into the Golf course ditch. The 600mm ø culvert further bifurcates into twin 300mm ø and simple 300mm ø pipes which cross the Tubber Lane Road and join with the flows from the 750mm ø 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 3rd 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 ø concrete structures.

A new 900mm ø 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.

UK and Ireland Office Locations