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Forward thinking in greater Dublin : an example of SuDS as an integral part to planning application.

Réflexion sur le futur de Dublin et ses environs : un exemple de système de drainage urbain intégré au plan d'aménagement des sols.

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RESUME

Ce document présente en détail la conception d'un système de drainage et de collecte pour les eaux de pluie pour un re-développement à "Anglesea Road". Ce document introduit aussi l'étude faite en 2004 sur la stratégie de drainage pour la région de Dublin et ses Environs et la revue de ses critères de références pour les précipitations exceptionnelles.

La conception du système de précipitation exceptionnelle à "Anglesea Road" intègre un système de régénération des eaux de pluie qui est utilisée pour les chasses d'eau en plus de la conception du système de drainage urbain "soutenable" utilisant des étangs dont le fond comprend une membrane étanche afin d'améliorer la qualité de l'eau et de diminuer l'écoulement avec aussi une route comprenant un enrobage drainant.

ABSTRACT

This paper details on the concept design of the stormwater drainage and rainwater harvesting system for a re-development at Anglesea Road. It also provides an overview of the Greater Dublin Strategic Drainage System Policies (GSDSDS, 2004) for Stormwater, which current best practise in Ireland. The Stormwater design at Anglesea Rd features an integration of a rainwater harvesting system for toilet flushing in addition to the SuDS design of a lined pond/ wetland for water quality improvement and flow attenuation as well as a permeable pavement.

KEY WORDS

Rainwater harvesting system, local policies, planning application

1 INTRODUCTION

This paper provides an overview of stormwater drainage policies for new developments in the Greater Dublin Area and details on Sustainable Drainage Design of a proposed re-development at Anglesea Rd.

The Water Framework Directive (WFD), now incorporated into Irish law requires as an objective the achievement of “good ecological status” for surface waters by 2015. A key tenet of this policy document is that the requirements of the WFD cannot be met unless sustainable drainage systems and a commitment to best practice and continual improvements are implemented in developments.

Water demand in the Greater Dublin Area (GDA) has been increasing steadily for many years in line with increases in population and growth in the overall level of economic activity. National Spatial Strategy projections to 2030 indicate a long-term continuance of this growth trend. The current GDA water supply/demand balance has been on a knife-edge for many years with average daily demand frequently matching peak production outputs in the region. Circa 2015, forecast average demand will have reached the upper sustainable limit of peak production capabilities therefore alternative sources of water must be provided, however it is recognised that the prevention of leakage and continuing to utilise best practice in the conservation of water is a high priority. This can be achieved through the production of a Water Management Strategy for every development that specifies the following:

- The use of water conservation appliances in the buildings
- The use of rainwater harvesting
- The use of Sustainable Urban Drainage

Water conservation appliances: - Although the consumption of treated water depends a lot on the behaviour of consumers, designers should seek to place as little demand on the network by incorporating water saving taps, eco –flush toilet systems and water saving appliances.

Rainwater harvesting - Rainwater that is not absorbed into the ground is invariably piped either directly into a watercourse or a sewerage treatment plant. In times of high rainfall this adds to the risk of local flooding. Harvesting rainwater not only captures run-off before it enters the drainage system but also reduces consumption of treated water from the main supply. Harvesting systems are linked to the supply system of a building, providing water for landscape irrigation or the flushing of toilets. Although regulations allow for the use of harvested rainwater for all purposes other than for drinking, issues such as continuity of supply, storage and concerns over potential health risks mean that its use for landscape irrigation or the flushing of toilets is appropriate.

Sustainable Drainage System (SuDS): - SuDS incorporate a series of elements that have been developed to mitigate the flows and pollution from runoff. The philosophy of SuDS is to replicate as close as possible the natural drainage from a site before the development and to treat runoff to remove pollutants, so reducing the impact on the receiving watercourse. SuDS can also provide additional environmental benefits such as wildlife habitat, improved aesthetics or community resource.

2 SUDS DESIGN CONCEPT

The design was carried out using the general policy guidelines as outlined in the Greater Dublin Strategic Design Study (GSDSDS) which is regarded as current best practice for design of SuDS in Ireland. The GSDSDS sets out that drainage design should try and replicate, in a general way, the same rainfall-runoff characteristics for the pre-development condition of the site. SuDS drainage design consists of the following:

1. River Water Quality Protection
2. River Regime Protection
3. River Flood Protection

2.1 River Water Quality protection

Water quality protection is provision of either interception and/ or treatment volume.

Interception storage takes account of the first 5mm of rainfall and is generally provided by means of source controls using infiltration trenches for roof runoff and filter drains for road runoff. At the Anglesea Road development this is realised by using a permeable pavement in addition to the rainwater harvesting system.

For events larger than surface water runoff treatment is provided by using a retention pond. This storage volume is the permanent wet pool of the retention pond.

2.2 River Regime Protection

River regime protection is achieved by limiting the discharge to Greenfield runoff rates to prevent erosion of the downstream waters. This is best evaluated using a simulation model to calculate the required volume by using the estimated Greenfield runoff rates as fixed throttle rates for the 1, 30 and 100-year return period. In practise this is achieved by constructing throttle outlets from retention pond.

2.3 River flood protection

The volumetric analysis for river flood protection is a comparison of pre and post-development runoff volumes and can be described as the long-term storage volume. The objective is to limit runoff discharge to the river after development to the same as that, which occurred prior to development. As the requirement for the proposed development at Anglesea Road was set to provide river flood protection for a 100-year storm event, the increase caused by the proposed development must be stored onsite.

3 SUMMARY OF SUDS PROPOSAL

A lined wetland/ pond system is proposed to mitigate the potential water quality and amenity impacts arising from the development at Anglesea Road. The pond is incorporated into the landscaping design and provide for an aesthetic site improvement and increase the amenity value.

In addition, a permeable pavement will provide water quality improvement and flow attenuation of the road and car park areas. The permeable pavement consist of a number of car park spaces and the access road and this may be constructed using pervious tarmac or block pavers. This system may have to be lined, dependant on groundwater conditions. Careful design and construction are required to prevent the system from clogging. Adequate maintenance would also be required for long-term performance. The following section outlines details of the preferred option.

The permeable pavement will provide filtration of pollutants as well as flow attenuation. Dependant on ground conditions, the system may be designed as 'open system' and provide groundwater recharge or lined. A variety of systems are available and these generally consist of pervious tarmac or permeable block pavers. The rainwater harvesting system is proposed to be installed for toilet flushing of up to 10 apartment units. It is recommended to provide an underground tank system of 4 to 10 m³ storage. The unit should be supplemented by a mains supply incorporating backflow prevention to ensure adequate performance of the facilities in the case of long periods of drought. The system shall be installed with a minimum water level of the daily supply and will be situated in the underground car park to allow for maintenance access.

3.1 Water Quality Pond with extended Detention

The water quality pond is designed with a permanent water pool of 75m³ and an extended detention of 66m³ to attenuate flow of up to 100-year return period. It is designed with a sedimentation forebay to reduce sediment input into the pond and an overflow chamber to bypass large events may be considered (CIRIA, 2004). It is recommended to integrate the pond into the landscaping of the development and to provide appropriate safety measures along with a water fountain and walk bridge to improve its amenity value. A fountain will also be advantageous in terms of aeration and reduction in pollutants and algae growth. Surface water would be conveyed to the water quality pond using a piped system. In accordance with best practise, the increase in runoff from the development would be offset by the use of the water quality pond within the development area.

The design makes an allowance for climate change impacts by the application of a 10% increase in design rainfall volume. Additionally, for water quality purposes, a permanent water level will be maintained in the pond and the pond will be lined with a low-permeability layer/liner to the minimum water level. Reed growth will be encouraged at the permanent water level mark to facilitate the reduction of pollutants (sediment, heavy metals and organic matter).

Recognition has been made of the minor health and safety hazard that ponds pose. The maximum gradient for the first 2 metres in from the perimeter of the permanent pool is to be 1 in 5. Additionally, the pond will have a sufficiently thick planting regime around the perimeter to reduce the possibility of residents from entering the water body. A sign will be provided in a visible location near the perimeter / gated entrance to the area of the pond(s) warning residents/community of safety issues.

Flow from the ponds will be restricted using an undersized pipe, orifice or vortex control device. An overflow chamber with bypass mechanism and consideration of overland flow routes will be provided to facilitate the safe passage of water in excess of the 100-year event.

The water quality pond will form an integral part in offsetting both the hydraulic and water quality impacts of the development. The pond will further reduce fine sediments, heavy metals, nutrients and toxicants before discharging to the receiving waters. The permanent pool is designed for water quality treatment and the adjacent green area provides flood attenuation for extreme events. During dry periods this area is available for recreational purposes. A fountain will provide aeration and as a result improve aerobic pollutant decomposition.

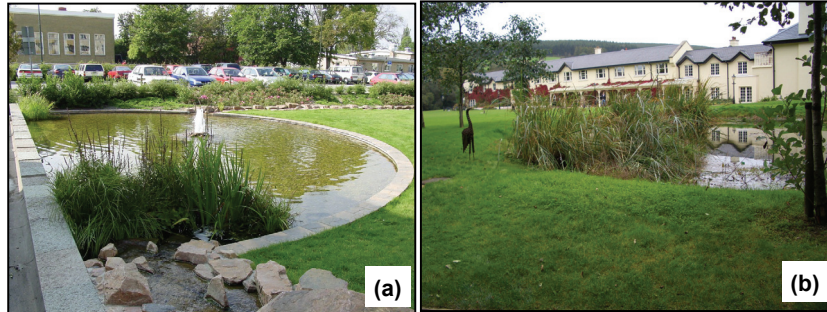


Figure 3-1 : Extended detention integrated into landscaping ; (a) Example from Eco City in Malmo, Sweden; (b) Example Fire Fighting/ SUDS Pond in Wlchlow, Ireland

3.2 Permeable Pavement

Permeable pavement reduces runoff rates and flow volumes from urban areas. They attenuate runoff while preserving the value of the area for urban development. Permeable pavements allow rainwater to infiltrate through the surface and into the underlying construction layer, where water is stored prior to infiltration into the ground or being released to other drainage systems. Various techniques are available as permeable pavement and these generally consist of porous tarmac or solid block pavers with gaps to provide through flow of water.

Dependant on the ground condition and ground water table the permeable pavement may be designed as an 'open system' to promote groundwater recharge or lined system to prevent groundwater ingress. Outflow from the permeable pavement system will be conveyed to the water quality pond for final polishing prior to discharge to the River Dodder.

4 RAINWATER HARVESTING SYSTEM

4.1 Introduction

The rainwater harvesting system is proposed to use roof waters only. Harvesting rainwater not only captures run-off before it enters the drainage system but also reduces consumption of treated water from the mains supply. Harvesting systems are linked to the secondary supply system of a building, providing water for landscape irrigation or the flushing of toilets. It is noted that a potential expensive treatment system would be required to facilitate use for other purposes. Demand balance modelling is required to provide data on the number of apartment units that can be effectively supplied and the tank size required. These details are provided in the following section.

4.2 Demand Balance Modelling

To undertake a demand balance model, supply and demand have to be estimated. This is carried out by comparing the daily demand with supply. The supply for rainwater harvesting system is dependant on the roof area, its runoff characteristics and the local rainfall pattern. Long-term time series data of 10-year data (1992 –2001) for Dublin, in daily intervals was used to estimate the supply. Input parameters for the supply calculation are presented in Table 4-1.

Roof Area	Percentage runoff	Reduction for Filter	SAAR
[m ²]	[%]	[%]	[mm]
950	50%	10%	800

Table 4-1: Parameters used for the water supply calculations

Demand for toilet flushing was estimated from the average annual water demand for Dublin. Approximately 1/3 of this demand is used for toilet flushing (CIRIA, 2001a) and an 8.5% reduction is expected for systems with eco-flush or dual-flush system (EA, 2005). Figure 4-1 presents a breakdown of Irish average per capita demand. The percentage runoff is estimated from the roof characteristics and its use.

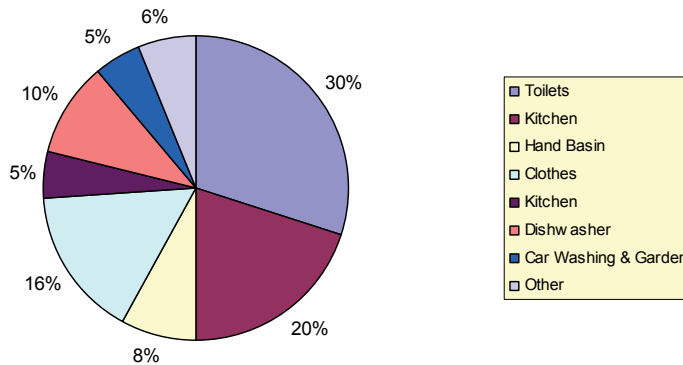


Figure 4-1 : Breakdown of Irish average per capita demand (Limerick Conservation Project, 2002)

CIRIA 539 (2001b) requires that a demand and supply investigation is undertaken. Tank sizes are then estimated dependant on manufacturer; i.e. for 5% of effective runoff a 15.2 m³ would be estimated, or for 5 % of annual demand of 18.1m³ tank would be estimated. Table 4-2 to 4-4 provides data on the tank size calculation and days of storage provided.

SAAR	Area	Runoff C.	Tank Size
[mm]	[m ²]	[-]	[m ³]
800	950	0.4	15.2

Table 4-2 : Tank size estimation using 5% of effective runoff

Demand	Capita	Tank Size
[L/Cap/Day]	[-]	[m ³]
31.82	33	19.2

Table 4-3 : Tank size estimation using 5% of demand

Storage	Usage	Days Storage
[m ³]	[L]	[d]
19	1050	18.1

Table 4-4: Days of storage provided

Using time series rainfall and comparing the daily supply with demand, an efficiency analysis of the proposed tank size can be undertaken. Figure 4-3 shows a flow chart of the decision making process according to CIRIA 539. Equation 4-1 was used for the analysis of the supply and Equation 4-2 for the analysis of the demand. (CIRIA, 2001a, 2001b).

Equation 4-1

$$S = \frac{A \times (C_B - C_F) \times R}{1000}$$

where S: Daily Supply [m³]
 A: Rooftop Area [m²] (950m²)
 C_R: Runoff Coefficient [-] (0.5 for flat roofs)
 C_F: Filter Coefficient [-] (0.1 for down-pipe filters)
 R: Daily Rainfall [mm]

Equation 4-2

$$D = ADx(C_T - C_{EC}) \times P$$

where D: Daily Demand [m³]
 AD: Annual Demand of 148 [L/C/D] (RPS, 2005)
 P: Number of People [-]
 C_T: Coefficient for Toilet Flushing (0.3) [-]
 C_{EC}: Coefficient for EcoFlush System (0.08) [-] (EA, 2005)

The analysis was undertaken for a range of apartments supplied, and varying tank size. Efficiency results are presented in Figure4-3.

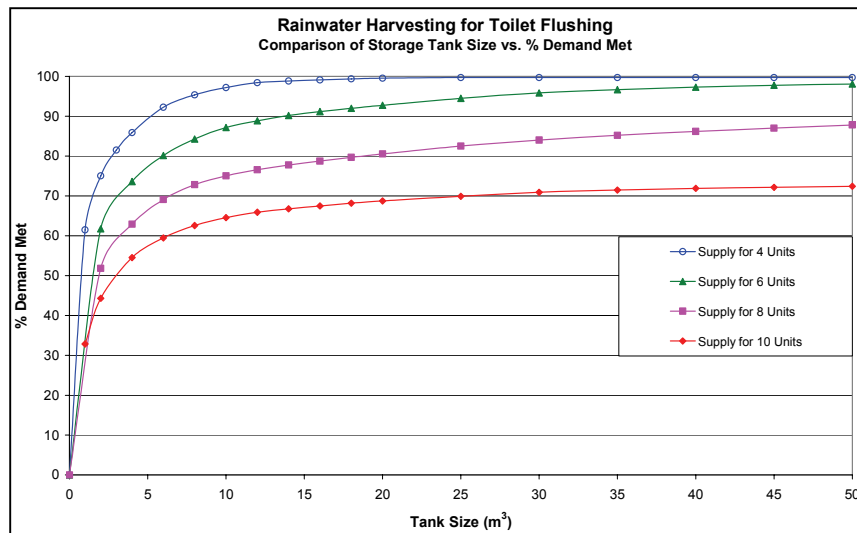


Figure 4-3 : Efficiency of rainwater harvesting system

It can be seen that a 15m³ tank would provide almost 100% of water for toilet flushing to 4 apartment units. Increasing this tank size to 18m³ would provide the same efficiency. The same tank sizes would provide an efficiency of 67 – 69% for 10 apartment units. A tank of more than 3 m³ would provide over 50% for each of the scenarios and it is recommended to use a standard tank size between 4 to 10m³ as this would provide the most efficiency.

Such storage tanks may be impractical as gravity fed systems, due to the increase in loading and space requirements. It is therefore recommended to install an underground storage system that provides flow back-up from mains supply during periods of drought and to provide the minimum daily demand.

5 CONCLUSION

This report concludes that the SuDS will mitigate any potential impacts from the proposed development on the water quality and quantity, as well as providing significant saving on potable water use.

The rainwater harvesting system is proposed to be installed for toilet flushing of up to 10 apartment units. It is recommended to provide an underground tank system of 4 to 10 m³ storage that has a mains supply incorporating backflow prevention to ensure adequate performance of the facilities in the case of long periods of drought. The system shall be installed with a minimum water level of the daily supply and will be situated in the underground car park for access.

A permeable pavement and a water quality pond with extended detention will provide for water quality improvement and flow attenuation. It is recommended to integrate the pond into the landscaping of the development and to provide appropriate safety measures along with a water fountain and walk bridge to improve its amenity value. A fountain will also be advantageous in terms of aeration and reduction in pollutants and algae growth.

The permeable pavement will provide filtration of pollutants as well as flow attenuation. Dependant on ground conditions, the system may be designed as 'open system' and provide groundwater recharge or lined.

The storage systems are designed for a 1 in 100 year storm event to minimize impacts from flooding.

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