Disconnection of Surface Water Drainage – a Local Authority Perspective

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ABSTRACT
This paper argues the case for the disconnection of surface water from combined sewer systems drawing on experience gained from the European Interreg IIIB project 'Urban Water'. Data and examples drawn from Netherlands and Germany are applied in the Local Authority area of Renfrewshire in Scotland. Disconnection is increasingly welcomed by local authorities to meet social, environmental and safety (from flooding) criteria. Unfortunately, traditional, bolt-on or end-of-pipe solutions tend to result in a degraded and piecemeal infrastructure which is expensive and difficult to manage or improve. Further, the limited availability of funding, and the acuteness of flooding problems, means that the more sustainable opportunities provided by watercourses can be readily overlooked. Disconnection of surface water focuses on controlling the water at source thereby providing a rationale for integrated use of land for water storage and other uses.

The disconnection options specifically applicable in Renfrewshire are reviewed and examined, drawing on experiences from the European case studies. The paper addresses the evaluation of disconnection options, the means of promoting disconnection and the value of disconnection targets. Results from disconnection programmes are presented, with information on methods, costs and savings. The paper concludes by presenting the disconnection targets used by the various parties involved in the project.

KEYWORDS
Flooding, Disconnection, Surface Water Drainage, Combined Sewers, Local Authority,

INTRODUCTION
Improved water bodies are a goal of many communities. Unfortunately, urban watercourses are frequently severely modified and are effectively engineered infrastructure with fragmented responsibilities for their maintenance. Drainage improvements tend to be bolted on to existing infrastructure to give lowest cost solutions which meet the specific concerns of one body, and which often do not give the optimum benefit to all. The result is a degraded and piecemeal infrastructure which is expensive and difficult to manage or improve by the various bodies responsible, causing nuisance

both to residents and on a wider scale. A further issue is that statutory requirements and acute flooding problems take priority for available funding so that the more sustainable opportunities provided by watercourses can be readily overlooked unless there is collaboration and pooling of resources. It is critical for the improvement of water quality and status of urban watercourses, that the quality and rate of flow into them is assured and disconnection of flow from sewer systems is essential for this to be achieved.

Joint studies have examined the issues of disconnection in the Interreg IIIB project 'URBAN WATER', which had eight partners in France, UK, the Netherlands and Germany. Data were gathered from project partners, who were local authority based, in Nijmegen, Arnhem and Nieuwegein, (the Netherlands) Lippebewand and Emscher-genossenschaft (Germany), Lille Metropole (France), and Renfrewshire (UK).

Drawing on the European knowledge, a number of proposals are made which have application in the UK, particularly Renfrewshire, including; the concept of a ***Virtual Watercourse*** to assist in the planning process; the introduction of a ***Water Vision*** (Jefferies et. al. 2008) to assist in public and stakeholder understanding of changed approaches to managing surface water drainage; the role of a ***Water Vision Manager*** or ***Champion*** within local authorities to facilitate those changes; and ***Charging For Surface Water***. Several of these approaches presume improved quality of the receiving water and this will follow from disconnection. The four countries in the Interreg IIIB project have actively undertaken disconnection projects but the motivation for each was very different.

Flood hazard management and maintaining quality of receiving water should be complementary aspects when undertaking improvements in the management of surface water drainage. Currently, flooding is often viewed from a risk triangle viewpoint, but pollution is not. Figure 1 shows the common issues when considering surface water flooding and pollution from a combined hazard perspective. Flood control projects (e.g. a disconnection scheme) will also improve receiving water quality and should be considered in the same risk / benefit assessment process.

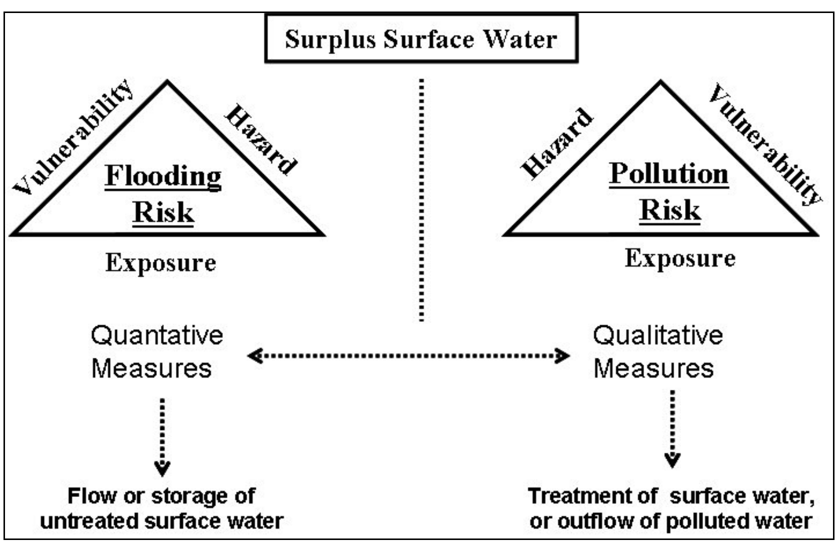

Figure 1 The combined hazards of surface water flooding and pollution

In Scotland the driver for disconnection is the control of surface water to the sewer system to prevent a combination of flooding and/ or combined sewer overflow (CSO) spills. In the Netherlands, Germany and northern France, stormwater is disconnected from the sewer system to reduce or prevent CSO-spills and improve receiving water qualities.

The disconnection of surface water from combined sewer systems will become increasingly important in meeting current and future environmental and performance targets within diminishing public budgets. Disconnection will inevitably require attenuation of surface water and infiltration where the ground conditions are suitable.

THE ATTENUTATION AND DISCONNECTION OPTIONS

The terminology of disconnection is somewhat misunderstood in the UK where the practice which resembles it most closely is Retrofit SUDS. In contrast, in the Netherlands, disconnection of rainwater always means that it is taken out of the piped system completely and conveyed to a surface water body or directly to groundwater.

There are many technical issues connected with disconnection which require resolution but are not addressed in this paper. Strategic issues include;

- Will the SUD system be above or below ground?
- Is there an escape route for the water during extreme events?
- Is a combination of functions allowed? For example, is infiltration with green space or with playground area acceptable?
- Will it be a new or existing system?
- Will the solution be interim, pending further water system changes, or will it be a final solution?
- If the receiving water is a culvert, can it be accessed at reasonable cost, and does it have capacity for extra inflows?
- What is the possibility for infiltration?
- Will the public SUDS facility be affected by private source control components upstream?
- Who will be responsible for maintenance in order to keep the systems working?

There are many factors influencing the technical option and chosen solution at a particular site. This decision will be influenced greatly by the distance to the receiving water body which may be of particularly high quality or sensitivity. The chosen disconnection solution may subsequently require enhanced treatment of surface water runoff. In some cases, the cost of diverting services may be a large component of the total costs of implementing the disconnection solution However; even a small scale project might facilitate flood control measures for a large catchment and may be worth progressing. Once strategic issues and technical factors such as those just described have resulted in a viable disconnection option the argument exists for initiating schemes that will provide significant incremental benefits and, for example, might easily avoid the need for a capital intensive flood prevention scheme and so form part of a sustainable Flood Management (SFM) project (FIAC 2005).

DISCONNECTION ISSUES FOR A LOCAL AUTHORITY

There are a number of obstacles to disconnection in the UK which are particular to Local Authorities. There is a presumption that infiltration will not work in most areas and that, as a result, disconnection is not possible. Water sensitive road designs are required to meet current environmental objectives, but there is currently no good practice guidance available to the roads engineer (Guz et. al. 2008) so traditional solutions are implemented. In general, technical solutions are always available to deal with water in urban areas and when used correctly they rarely cause problems. Unfortunately, the technical possibilities are frequently not specified at the project concept stage and the best environmental solutions are not implemented.

Scottish Planning Policy 7 (SPP7. Planning and Flooding. Scottish Executive 2004, NPPG7 in England & Wales) has had a crucial role in clarifying the various stakeholder roles when considering changes that impact on watercourses. More recently in Scotland, Planning Advice Note 79 (PAN79. Water and Drainage. Scot Exec 2006) focuses on the water and drainage services provided by Scottish Water. Unfortunately, its scope in addressing the urban water cycle is limited and, in particular, it fails to facilitate a holistic overview of the interaction between all water (above and below ground) and drainage networks since it makes only a passing reference to problems encountered which are not the responsibilities of Scottish Water such as fluvial flooding issues.

There is a need to identify the scope of institutional changes which will be required for disconnection to be delivered as part of the new approach to integrated catchment management, particularly within water utilities, environment agencies and local planning authorities. Key issues relate to:

- The need for shared /common databases, models and GIS for catchment analysis.
- Different planning processes that might best incorporate catchment management principles.
- Novel, integrated concepts such as a Water Vision.
- It is likely that water utilities will start charging for surface water into combined sewers.
- The potential opportunities available for funding for implementation of surface water management/ disconnection within each stakeholder organisation.

A broader planning view would also help in encouraging greater application of disconnection including incorporating the principles of planning gain. For example, accepting that, in particular circumstances, a new site (or the redevelopment of an old site) might be retrofitted / disconnected to allow a future development to proceed without SUDS. This could allow more development to go ahead in areas that are not feasible for disconnection and / or would not be considered for development due to existing sewerage constraints. Rejuvenating a natural watercourse as part of a disconnection strategy will require that additional land will occasionally be under water during times of heavy rainfall and this would have to be communicated to the local community through Local Plans.

Changed rules on capital receipts (local government sale of land) will also be necessary to ensure that land required for water storage or conveyance is not sold without clear conditions. Otherwise the land sale might frustrate the development of the improved surface water network or make it unachievable by the construction of new buildings or infrastructure.

EUROPEAN DISCONNECTION EXPERIENCE

The principal driver for disconnecting surface water from combined sewer systems in the areas studied in Europe is to prevent pollution of the receiving waters, primarily due to spillage from combined sewer overflows. The secondary driver is a reduction in the quantity of runoff which exacerbates watercourse peak flows. It was agreed at a national level in The Netherlands that combined sewer discharges (of flows and loads) would be reduced by 50% by 1 January 2006 but this ambitious target was not reached and the target date was extended to 2010. Initial proposals to meet this target involved the construction of storage tanks upstream from CSOs but disconnection is now viewed as a more sustainable solution. Several Local Authorities have now agreed with their Water Board that they will introduce the more sustainable technique of disconnection as opposed to implementing storage tanks. There are similar agreements in the Emscher area of Germany where the norm is to have a 15% reduction of discharge to the trunk sewer.

Evaluating Disconnection Options

For each disconnection project, studies were undertaken to determine the optimum balance between the traditional solution (constructing in-sewer storage volume) and disconnecting areas which currently drain to the combined sewer. Figure 2 shows typical results from modelling studies in Arnhem. The two different strategies for meeting the 50% reduction of CSO spills are shown (100% means the 50% spill reduction is met fully). The graph compares spill reduction for a given volume of storage and disconnected area.

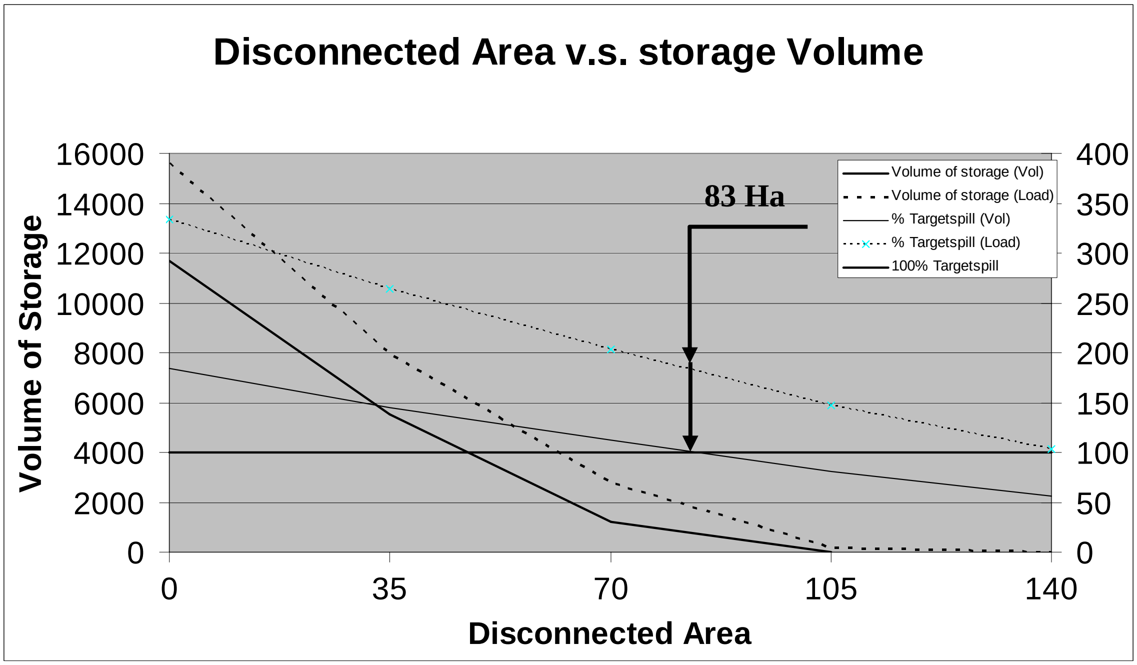

Figure 2 Selection of 83 Ha disconnection for Arnhem

The criterion selected was volume, for which 83 Ha requires to be disconnected. In contrast, 140 Ha would need to be disconnected to reduce spill loads by 50%. Storage with a total volume of 600 m^3 must also be constructed along with the 83Ha of disconnection to achieve the required reduction. This study illustrates the value of developing network simulation models to assess disconnection options.

Promoting and Communicating Disconnection

Integration of different urban improvement projects are considered important in The Netherlands. Some projects are justified by the benefits of disconnection alone, but many Local Authorities have guidance which requires that all improvements to public space should be carried out simultaneously to cause least disturbance to the public and to gain most cost efficiencies. In Arnhem, this is referred to as their BGB policy. BGB is a play on Dutch words and does not have a direct translation, but conveys both operational and strategic developments. The BGB policy message is that mundane actions of drainage and streetscape improvements can be phased together to give wider environmental improvements. Disconnection is promoted to the public through a water service point and through the BGB process. The Municipality of Arnhem provides a subsidy of €12, m^{-2} to stimulate disconnection activities.

Many municipalities in The Netherlands also have a ***Water Assessment*** (Watertoet) (Waterboard De Stichtse Rijnlanden 2004) which has the aim of creating a sound and resilient urban water system. The ***Water Plan*** delivers the short term targets of the ***Water Vision*** and disconnection is one of a range of measures to achieve this. The Nijmegen plan has a time horizon of 50 years with both short (4 years) and medium term (10-15 years) targets. The long term goal is a sound and resilient water system with 80 % of areas disconnected over 50 years. Nijmegen also has a Water Service Desk which provides information about the entire urban water system. The desk has a website

(Gemeente Nijmegen 2007) and a commitment to respond to all enquiries about the water system.

Disconnection Costs and Savings

The costs of disconnection (retrofit in UK) are critical for projects to proceed. Part of the Interreg IIIB project 'Urban Water' was to gather data on disconnection costs from the partners and summaries of the results are presented here. Table 1 gives the capital costs of disconnection expressed as a cost per m^2 in the three areas for which information was available. The data show that there is rough equivalence between the three authorities in two countries.

Table 1 Summary of Capital Costs for Disconnection

ORGANISATION	COST (€/M^2)
Nijmegen	22.8
Arnhem	19.2
Emschergenossenschaft /THS	23.4

In contrast, Emschergenossenschaft operates an extensive trunk sewer network and have a policy to encourage disconnection of surface water from their network. One contributor of such flow is a public housing company, THS, which has undertaken disconnection projects along with the rehabilitation of older housing stock. THS take the view that considerable financial benefit can be gained by investing in disconnection projects at the same time as improving their housing stock since a fee for connection of surface water to the combined sewer system will no longer be payable.

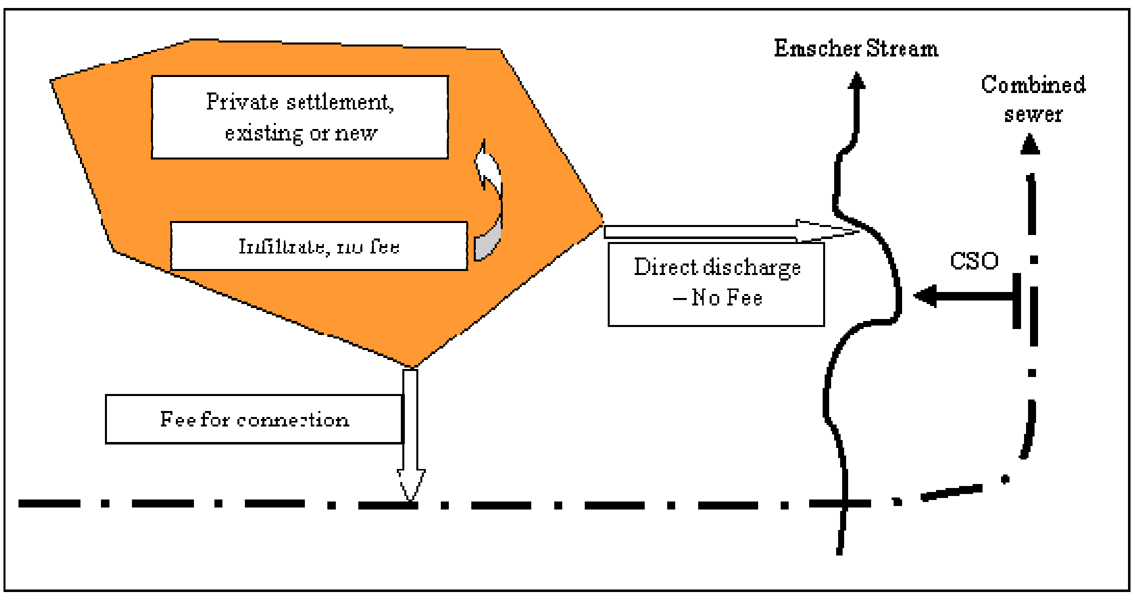

Figure 3 Emschergenossenschaft Fee Concept Diagram

Figure 3 shows the principles of disconnection charging used by Emschergenossenschaft in a diagrammatic form. The fee for discharging surface water into the trunk sewer system can be avoided by either infiltrating or by directly discharging to the Emscher river system provided the surface water quality is satisfactory. Data from THS (Table 2) show the savings which have been gained over a wide range of disconnection projects.

The public approach used by THS in the Emschergenossenschaft area compares with Nijmegen where householders are given €5 or €10 m^{-2} as an incentive to disconnect. Over a number of projects in the period 2001 - 2005, the cost of disconnection (of private areas) to Nijmegen has been approximately €800 per property. In response to market forces in 2006, the price dropped to € 400- €500 per property. More recent prices (for 2006-2007) are € 25 - 30 m^{-2} for public areas.

There have also been positive disconnection outcomes in Nijmegen where there have been no parallel projects (BGB in the language of Arnhem); such as streetscape works constructed at the same time as the disconnection project. In small scale projects where gullies have been removed and an infiltration device created, the costs have been relatively low to the recipient who in this case is the private householder. In one project, for example, 2 ha of impervious surface was disconnected for €7 to €10 m^{-2}.

Table 2 THS Disconnection Savings Summary

	NO OF HOUSING UNITS	**ANNUAL SAVING PER YEAR TOTAL**	**ANNUAL SAVING PER PROPERTY**
Disconnection of existing properties	1,728	37,553	€22
Disconnection of new properties	887	62,989	€71

Disconnection Targets

To be of maximum value, disconnection must be justified and planned on an area by area basis since each sub-catchment has specific needs. In the areas in Europe where disconnection is being put into practice, target areas for disconnection are set and these are summarised in Table 3. In Renfrewshire’s case, disconnection is seen as one element in achieving a paradigm shift to better incorporate the needs of water in the development processes and setting a tangible target would reinforce the changed thinking required.

The experience from these European disconnection programmes has been used to propose a target for Renfrewshire. Table 3 shows the targets used in the different locations. In Arnhem for example, there is the intention to disconnect 15 Ha of area which currently drains to combined sewers by 2019. This will be achieved through integrated projects which have a number of social environmental objectives drawn together using their integrating BGB policy.

Table 3 Disconnection targets in study areas

CITY	**AREA (HA) OR %**	**YEAR**	**CSO SPILLS**	**NOTE**
Arnhem	85	2010	50%	
Nijmegen	180	2019	50%	10 Ha per year
Nieuwegein			50%	
Emscher	15%	2020		
Renfrewshire	**14 Ha**	**15 year period**		**Potential target**

A target disconnection rate of 14Ha per annum in Renfrewshire would require the local authority to disconnect in the order of 400 metres of road per annum and this would require close cooperation between various parties when making road improvements. Daylighting 15% of local authority culverts by 2020 might be an adoptable disconnection target and in Renfrewshire, this would be 14 Ha per year.

APPLICATION TO A SCOTTISH LOCAL AUTHORITY

There are many drivers which will encourage the disconnection of surface water from existing sewer systems and many others which discourage it. While the overall drivers are legislative, environmental, economic and social, from the perspective of Local Authorities, the drivers tend to be either statutory or aspirational. This means that they are either required through government legislation or alternatively the local community has identified the need to meet a local environmental or social need.

The continuing change in public attitudes in favour of environmental improvements has created a desire for better access to clean watercourses (SEPA 1998). It is also important to recognise the demand for removal of economic or regeneration constraints from urban areas. In the Netherlands, as in many countries, houses adjacent to surface water are considered more valuable than those which are not and this is generally reflected in most countries. Disconnection of surface water from combined sewer systems into opened watercourses provides benefits for improving the attractiveness and quality of public space. It follows from the discussion above, that flooding risks will also be addressed.

Experience has shown that the Local Authority has an important role to play in the evaluation of disconnection options, and that their role is of equal importance as the drainage utility. It is expected in the future that storage of excess surface water will be above ground and it is likely that evaluation of options will be led by the Local Authority. All options have to be communicated to developers and the public and Renfrewshire Council has adopted the principles of the ***Water Vision*** from Dutch practice to assist with this process. Disconnection targets have not yet been fully embraced but they have proved to be useful in the development of possible approaches to be taken by the Council.

Disconnection will also require the pooling of finance on an opportunistic basis to ensure planned measures allow for cost effective use of monies which have been allocated for different purposes (e.g. from transportation, housing, social and environmental funds) and developers must be brought on board to a greater degree to deliver results. Funds may have to be diverted and the proposition has been suggested that in Renfrewshire, 10% of highway infrastructure investment could be subject to opportunistic water network improvements since highway drainage contributes to a significant proportion of watercourse degradation and flooding.

CONCLUSIONS

The study of disconnection techniques applied in a number of European municipalities in the EU Interreg IIIB project 'Urban Water' has shown that the practice of disconnection is widespread and a viable option for reducing the quantity of polluted water reaching watercourses.. Detailed application is variable throughout Europe including 100% disposal to ground where possible. Those locations where it is most successful have integrated policies where excess surface water drainage is just one of a number of social, economic and environmental drivers for a project. In particular, the integration of projects has led to pooling of financial resources and lower overall costs resulting in cost effective projects that benefit urban environments / townscapes.

There are technical issues which must be addressed in the disconnection process and it is not the intention of this paper to downplay their existence or complexity. However, traditionally, surface water drainage problems are seen as being purely technical/ financial. This project has shown that this restrictive paradigm leads to poorer, more expensive solutions.

The development of disconnection targets has been shown to be successful in Europe. A target total area or percentage of system to be disconnected is agreed in advance and complementary financial incentives and organisational arrangements put in place. In the Emscher region of Germany, reduction of drainage charges following disconnection has proved successful in achieving targets for disconnection. Acceptable targets for Renfrewshire have yet to be developed. However, Renfrewshire Council are currently considering the disconnection options in the context of UK constraints with a view to applying the strategy in the future.

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