Session - Management Of Drainage Near Source – Disconnection / Minimise Surface Water Entering Public Drainage

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ABSTRACT
Many combined sewer networks are currently constrained due to lack of capacity. Surface water entering the network may have an impact on the local environment by causing additional spills from Combined Sewer Overflows (CSOs) and flooding events. With the increasing number of developments taking place in Scotland, more and more demands are being placed upon the existing wastewater assets and infrastructure of the drainage utility, Scottish Water. The principal way of preventing these CSO spills/flooding events is to reduce the number of surface water connections to the combined sewer network and promote more surface water discharges to nearby watercourses.

The problem is being addressed by examining all development applications as they are considered by a drainage planning officer in the water authority. The research reported in this paper is investigating the conditions under which it is reasonable and practical for Scottish Water to accept surface water flows into its combined sewer network. This paper presents a summary of the initial findings of the research to date by examining a sample of the sites examined. The objective of the work is to develop a methodology to support a rigorous stance on the acceptance of surface water flows into the combined sewer network. The results have not as yet been obtained.

KEYWORDS
Scottish Water, Surface Water, Combined Sewer, Connection, Capacity, Constraints, Disconnection

INTRODUCTION
With the increasing number of developments taking place in Scotland, more and more demands are being placed upon existing wastewater assets and infrastructure (Water UK/WRc, 2007). Many of these networks are currently constrained due to lack of capacity, and the deliberate connection of surface water into the combined sewer network could have an impact on the local environment by causing additional spills from Combined Sewer Overflows (CSO's) and flooding events (Debo, and Reese, 2003).

There are many stakeholders supporting sustainable development of Scotland (Mason, 1998). One of the main issues facing developers is to how best to deal with surface water run-off in an appropriate manner. The discharge of surface water from a site should comply with the technical standards and specifications (Water UK/WRc, 2007) in order to:

" a) Protect the watercourse from pollution;
b) Not increase the flood risk from the watercourse downstream or upstream of the site;
c) Protect the morphology of the watercourse;
d) Provide ecological and aesthetic benefits;
e) Provide the required level of service against flooding for the development." (Water UK/WRc, 2007)

Benefits of reduced surface water flows have been well researched and documented previously (Dennison, 1996). One benefit is the significant financial savings achieved through reduced operational and maintenance costs on assets and infrastructure as a result of the non-connection of surface water from the combined sewer network (Scottish Executive, 2006). However for non-connection to be a viable option there requires to be a solid justification.

This paper highlights the initial findings of the research project which seeks to;

- Investigate if there is any reasonable justification for Scottish Water **not** to permit the discharge of surface water to the combined sewer network in any of the sites investigated.
- Investigate the factors influencing Scottish Water's decision making process to allow a proposed development site's surface water to connect to the combined sewer network ,
- Propose a methodology to support a protocol on the acceptance of surface water flows into the combined sewer network.

DATA COLLECTION

The period of data collection enabled a data set to be established with detailed information on over 175 sites for further investigation.

A sample of this data set is presented in this paper and evaluated to illustrate the data and to demonstrate the initial development of the protocol. This sample consists of ten sites, of which four sites have the surface water connected to the combined sewer network and six have the surface water discharging to the surface water sewer or nearby watercourse. A large number of data fields were collected. One of these sample sites (Site 8) was selected to demonstrate the data collected and this is presented in Table 1 and 2 and in Figure 1.

Table 1. Specific Site Information (related to Site 8).

Development Details	**Site 8**
Location of site, large + detailed plan	Yes
Type of development: residential/industrial/mixed	Residential
Type of site: green field/ brown field	Greenfield
Number of units	70
Type of sewer present: surface water/combined	Foul, Surface Water plus Combined
Distance to watercourse	193metres
Difficulties in reaching watercourse: railway/road crossings, etc	None
Distance to surface water sewer (m)	Adjacent
Size of surface water sewer (mm)	600mm
Distance to combined sewer (m)	Adjacent
Size of combined sewer (mm)	525mm
Distance to foul sewer (m)	Adjacent
Size of foul sewer (mm)	300mm

A location plan is always provided with all development site enquiries and an example is included as Figure 1.

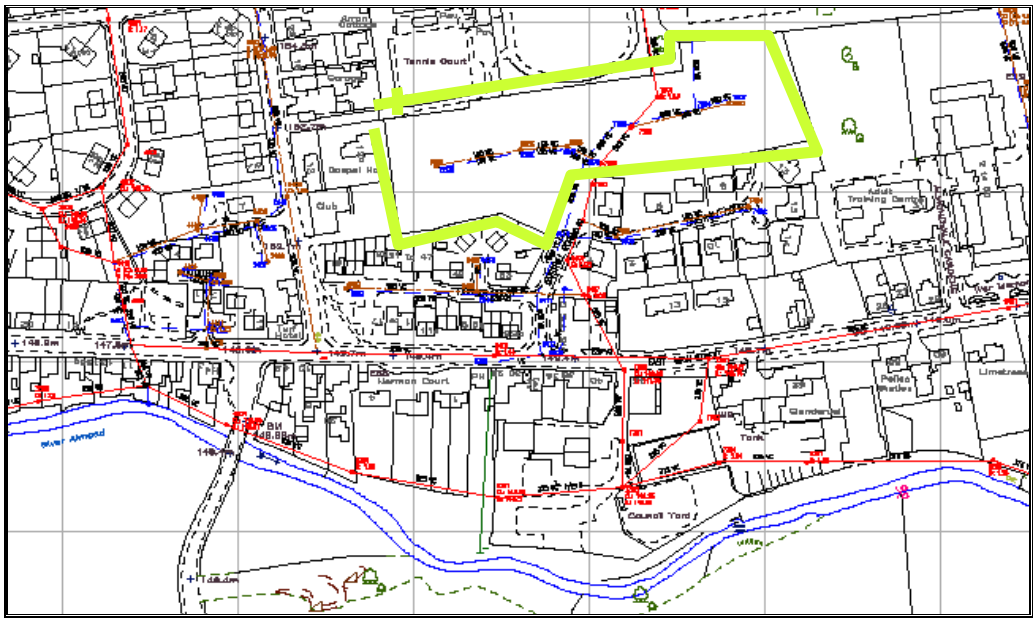

Figure 1. Typical Location Plan (for Site 8).

Supporting information is also collected as shown in Table 2.

Table 2. Typical Supporting Information (for Site 8).

Development Details	**Site 8**
Development site name	XXXXXX
Type of residential unit: flats, houses, other	Houses
Impermeable area (m2)	2.1Ha
Volume of surface water litres per second or 2 year green field runoff	2Year Greenfield Runoff
Is the site near an historical flooding location?	No
Name of receiving watercourse	XXXX
Are there any constraints on surface water sewer	No
Does surface water require pumping	No
Are there any constraints on the combined sewer	Yes
Are there any upgrading or improvement works occurring nearby	No
Are there any upgrading or improvement works planned nearby	No
Does the site require a drainage impact assessment (DIA)	Yes
Is there any surface water attenuation	No
Are there any sustainable urban drainage systems (suds) proposed	No

Table 3 shows the destination of the surface water and the cost associated with connection.

Table 3. Financial information related to each sample investigated.

Site	Surface Water Connected to Combined Sewer	Surface Water Connected to Watercourse	Surface Water Connected to Surface Water Sewer	Construction Cost (£)
1	Yes	No	No	100,000[1]
2	Yes	No	No	300,000
3	Yes	No	No	5,000[3]
4	Yes	No	No	5,000[2]
5	No	Yes	No	5,000[2]
6	No	Yes	No	5,000[2]
7	No	Yes	No	5,000[2]
8	No	No	Yes	5,000[2]
9	No	No	Yes	5,000[2]
10	No	No	Yes	5,000[2]

[1] Costs were as part of the overall SUDS of the site
[2] Costs rounded up to £5,000 as an indicative construction cost for connecting into the adjacent sewer
[3] Costs have been estimated as they were part of the sites overall drainage costs because this connected into the combined sewer network

Comment: Lots of rounding – needs work later

DATA ANALYSIS

10 sites investigated in the sample were chosen at random from the data set collected. Table 4 describes those received by the Planning and Development team where the developer had requested their surface water to be discharged to the combined sewer network, Table 5 describes three sites with requested discharges their surface water to a nearby watercourse and Table 6 describes three sites planned to connected to a nearby surface water sewer network.

Table 4. Sites 1 – 4 Surface water to the combined sewer network

Site	Surface Water	Type of Development (Residential units)	Type of Site	Cost of Construction £
1	Flows Attenuated below previous Discharge	157	Brownfield	100,000
2	2 Year Greenfield Runoff	29 + Industrial Units	Brownfield	238,190
3	Free Discharge	3	Brownfield	5,000
4	Free Discharge	6	Brownfield	5,000

Site 1 – The proposed development is on a Brownfield site. The developer demonstrated that they would reduce the volume of surface water below that of the flows currently entering the combined sewer network. Also that all reasonable and practical measures had been addressed and thus the connection was approved. The site drainage was required to be on a separate system as per Sewers For Scotland regulations. The site proposed is for 157 residential units.

There was a sewer water sewer and a watercourse both within a 500m radius. However the difficulties face by the developer in reaching either was many. As this is an urban redevelopment, the cost of traffic management alone would be been excessive. The combined sewer adjacent to the site has a number of historical flooding locations. By demonstrating that the overall flow rate will be reduced to that of previous, the benefit was accepted, over the more costly option of discharging the surface water to the surface sewer or watercourse.

The cost of £100,000 has been estimated as the cost of attenuation was incorporated into the sites overall SUDS.

Site 2 – The proposed development is on a Brownfield site in an urban area. The developer requested the surface water to be connected in addition to the increase in foul flows. The developer was required to upgrade the size of the existing combined sewer in order to provide additional storage. The cost of construction plus, detailed design, traffic management and the modelling assessment etc all required to be funded by the developer and was approximately £238,190. Further investigation revealed that an indicative cost of taking the surface water to the watercourse would have been in excess of £500,000.

Site 3 – The proposed development is on a small Brownfield site in an urban area. The existing house is to be demolished and three constructed within the sites boundary. This site requested the surface water to be discharged to the existing combined sewer network, despite a surface water sewer being close by. The topography of the site would have meant a very deep sewer or the installation of a surface water pump, due to the surface water sewer being several metres in height above the site boundary. A decision was taken on the basis that the scale of development did not justify the excessive disconnection cost in discharging to the surface water sewer. The benefit on insisting the surface water be discharged there would have been negligible and the cost more than likely would have made the development unviable. The flow figures were low and below the threshold of a significant detrimental impact. An indicative cost of £5,000 has been included as reference although the costs may be lower due to being part of the overall sites drainage costs.

Site 4 – This small inner city development requested the surface water to be discharged to the adjacent combined sewer network. The proposed development is on a Brownfield site. A decision was taken to permit this connection based on the site details and scale of development as six flats and not to request a disconnection. The sites location meant that there was no surface water sewer or watercourse in the immediate vicinity and the cost of reaching either would have made the site financially unviable. The flow figures were low and below the threshold of a significant detrimental impact. An indicative cost of £5,000 has been included as reference although the costs may be lower due to being part of the overall sites drainage costs.

Table 5. Sites 5 – 7 Surface water to a watercourse

Site	Type of Development (Residential Units)	Distance to Watercourse	Type of Site	Cost of Construction £
5	300	Runs through site	Greenfield	5,000
6	300	Adjacent	Greenfield	5,000
7	300	Adjacent	Greenfield	5,000

Sites 5, 6 – 7 each feature planning permission for approximately 300 houses and are situated on Greenfield sites with a small watercourse running through or adjacent. It is intended that the surface water will be incorporated into the overall SUDS of each site. Each site is to be drained on a separate system of drainage with the foul flows only discharging to the existing combined sewer network. An indicative cost of £5,000 has been included as reference although the costs may be lower due to being part of the overall sites drainage costs.

Table 6. Sites 8 – 10 Surface water to the surface water sewer network

Site	Type of Development (Residential Units)	Distance to Watercourse	Type of Site	Cost of Construction £
8	300	Runs through site	Greenfield	5,000
9	46	Adjacent	Greenfield	5,000
10	425	Adjacent	Greenfield	5,000

Site 8 – This proposed development features approximately 300 houses and is situated on a Greenfield site within an urban area. There are recently installed surface water sewers adjacent to the site due to recent development sin the area. These surface water sewers then discharge to a watercourse which runs nearby.

Site 9 – This proposed development features approximately 46 flats and is situated on a Greenfield site with a small watercourse running nearby on its eastern boundary. Due to recent development there is an existing surface water sewer which runs along the edge of the northern boundary of the site prior to discharging to the aforementioned watercourse.

Sites 8 and 9 - are to be drained on a separate system of drainage with the foul flows only discharging to the foul sewer, prior to connecting to the combined sewer network downstream. The cost of connecting the surface water sewer to the nearby surface water sewers are minimal due to their close proximity. It is intended that the surface water will be incorporated into the overall sites SUDS prior to discharge. An indicative cost of £5,000 has been included as reference although the costs may be lower due to being part of the overall sites drainage costs.

Site 10 – This proposed development features approximately 425 houses and is situated on a Greenfield site. There is a small watercourse located near the sites southern boundary. The site is to be drained on a separate system of drainage with the foul flows only discharging to the foul sewer, prior to connecting to the combined sewer network downstream. The developer was required provide additional storage on the combined sewer network following a Drainage Impact Assessment. The cost to support the additional foul only flows has been quoted at £700,000.

Common Site Features

This paper has identified a number of trends from the sample investigated. Firstly, the majority of sites discharge the surface water to a surface water sewer or a watercourse. These sites were located on Greenfield sites in rural locations on the edge of town's and villages, close to recent developments, which have previously installed surface water systems.

The sites discharging surface water to the combined sewer, are all Brownfield sites and in urban areas. There are two large residential sites and two small residential sites. The developer is faced with a financial implication on the large sites, regarding the discharge, whereas the smaller sites have relatively small surface water flows and incur no additional costs.

The costs applicable to developing sites, regardless of size and not connecting their surface water to the combined sewer network, are considerably lower primarily as there are no mitigation works required.

DEVELOPMENT OF GENERAL RULES

All development sites are required to have a separate system of drainage i.e. a foul only sewer and a surface water sewer. In some cases the sites foul and surface water sewers will discharge their flows using a connecting manhole to the combined sewer. Depending upon the size of the site to be developed, there will most probably be a financial cost to the developer in providing additional storage capacity and to Scottish Water who will face additional surface water flows unnecessarily consuming capacity and requiring treatment. The rule being that the greater site area the greater financial implication. The larger the flow equals a reduction in carrying capacity and increase in costs through greater volumes requiring treatment.

The factors influencing a decision to discharge the surface water from a new development to the combined sewer are many and varied. The research has identified the main issues to be flow rate, financial viability, and capacity of the receiving network. This tripartite relationship (Figure 2) is supported by the location of the site and difficulties faced by the developer such as topography, road/rail crossings.

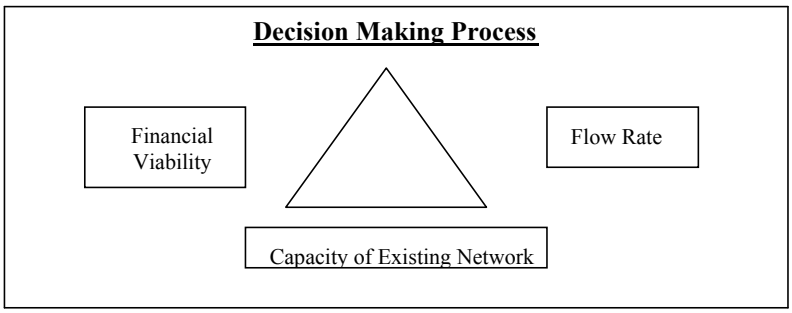

Figure 2. Tripartite Relationship.

Rule 1 Flow Rate

A stipulation placed upon all of these developments is that the surface water must be restricted to a two year Greenfield Runoff rate or less. Scottish Water has a policy of not objecting to development, and will provide funding for Part 4 assets. Any significant detrimental impact on Part 2 and 3 assets must be funded by the developer (Figure 3).

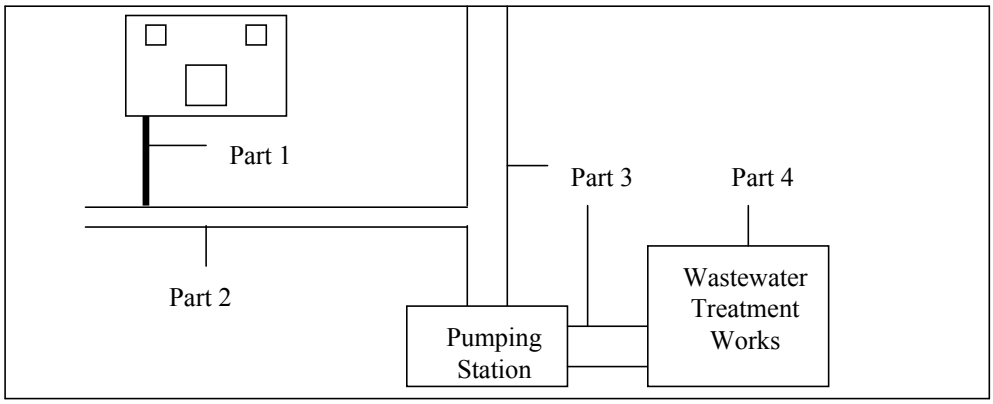

Figure 3. Illustration of Parts 1 to 4 Infrastructure

In cases where it is demonstrated that the post development flows are less than the pre-development flows, then an overall hydraulic benefit will be provided and thus accepted. The surface water flow rate figure is determined by the size of the site (Butler and Davies, 2000) and is influenced by the rainfall patterns across Scotland. The flow rate is very important as demonstrated by Sites 1 – 4 and is closely related to the financial viability of the site, as the greater the flow the greater the cost.

Sites 3 and 4 were for three and six residential properties respectively and thus the overall contributing flows were relatively small. The flows were determined to be negligible and the attenuation proposed was sufficient. The financial implications of connecting the surface water other than to the combined sewer network would have made the development sites unviable. Sites 1 and 2 were developing larger numbers of residential units and could accommodate the additional costs for extra surface water attenuation or mitigation on the combined sewer network.

Rule 2 Financial Viability
The financial viability of developing a site is fundamentally important. A notable factor is the disposal of surface water, as discharge of surface water to the combined sewer carries a major cost implication. Two sites identified out of the ten lie a little outside of the norm. Firstly, Site 10 involved a large cost for connecting only the sites foul flows. However, it is important to note that, if the surface water was also to be included, the storage options costing £700,000 would be insufficient and the cost of the ultimate option would be significantly higher. The second site, Site 1 demonstrated an overall reduction in the total flow. This reduction was achieved through attenuating on site, prior to entering the combined sewer and was thus providing an overall improvement to the existing situation. This arrangement presented a solution which was deemed acceptable.

Scottish Water will provide funding to the developer for the cost of provision of Parts 2 and 3 assets through the Reasonable Cost Contribution scheme. This is applicable for all new connections, whether it is a new development or a first time connection to an existing property. Although the developer is responsible for funding any costs over and above the reasonable cost limit, the funding from the RCC scheme nevertheless reduces the impact and assists the financial viability of the development.

Rule 3 Capacity of Existing Network
The historical under-funding of wastewater assets and infrastructure across Scotland has seen the available capacity within the networks exhausted. Due to the scale of new development, and knowledge of the condition of the existing combined sewer downstream, a number of these sites were required to carry out a Drainage Impact Assessment (DIA) (Scottish Water 2007). These assessments are funded by the developer and only one would have had a significant detrimental impact upon the combined sewer network, however this was for Foul flows only and can be discounted. By connecting the surface water into the combined sewer the capacity for future developments is reduced and existing flooding events will be exacerbated.

FURTHER ANALYSIS

Further investigation and examination will focus on the full number of development site details collected. This investigation will build upon and develop the findings that have been identified within this sample. There will be an investigation into the difference in costs of developing on Greenfield sites and Brownfield Sites and whether the developments are in Urban or Rural locations identifying the different issues faced.

Where the surface water is allowed to connect to the combined sewer network to achieve an overall reduction in the number of flooding events and CSO spills, is there a case for Scottish Water to co-fund a solution with the developer. Similarly is there a case for another body to be involved and contribute some financial support to achieve an environmental improvement downstream of the proposed development.

Although this paper presents a detailed investigation of the sample, further investigation is required to assess whether it would have been preferable to discharge to the surface water sewer or watercourse for the entire data set collected.

CONCLUSIONS

There is a statutory duty on the developer to provide separate foul and surface water drainage systems for both Greenfield and Brownfield developments. However the discharge of surface water to a nearby Scottish Water surface water sewer system or watercourse is not always available. In these circumstances an application is made to discharge the developments surface water runoff to the combined sewer network.

The objective of this work is to develop a methodology to support a rigorous stance on the acceptance of surface water flows into the combined sewer network. This paper has initially highlighted that there was no reasonable justification for Scottish Water not to permit the discharge of surface water to the combined sewer network in any of the sample sites investigated. From the sample, the numbers of sites requesting the discharge of surface water into the combined sewer are in the minority and on Brownfield sites in densely populated urban areas.

Since starting this research a process has been installed whereby when requesting a connection into the wastewater network, all enquiries are required to be in the form of a completed Development Impact Assessment form, so that all relevant is provided at the outset.

The factors influencing Scottish Water's decision making process upon receiving the request from the developer to discharge the surface water to the combined sewer are many and varied. This paper has identified the main conditions under which it is reasonable and practical for Scottish Water to accept surface water flows into its combined sewer network to be flow rate, financial viability, and capacity of the receiving network, supported by many other factors such as topography and difficulties in reaching alternative discharge locations.

This paper has identified that the planning officer faces a difficulty in advising the developer to discharge the surface water to another location other than the combined sewer in that this may mean the site is financially unviable.

There is a requirement for the production of a process for use when there is an enquiry received and the flow figures for the post developments are greater than pre-development. If the developer demonstrated that the post development flows are less than the pre development flows then an overall hydraulic benefit will be provided and thus accepted. A possible non acceptance scenario would be on the significant increase in the biological loading of the flow.

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