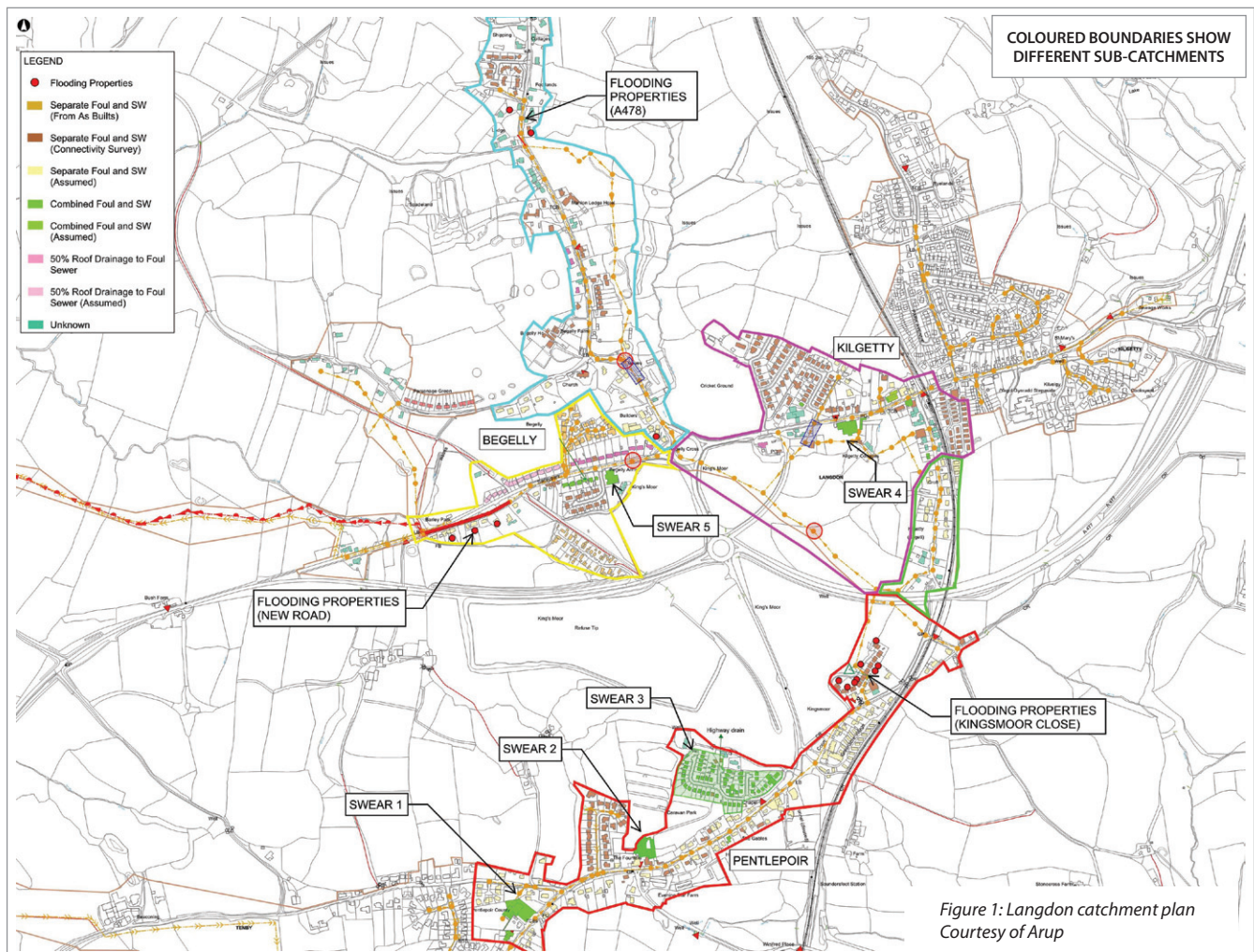


Begelly & Kilgetty Flood Alleviation Scheme

using a catchment-wide approach to reduce the risk of localised flooding of properties within the Langdon catchment

by Robert Forster MEng

There are 13 properties and one highway within the Langdon catchment in Pembrokeshire that feature on the Dŵr Cymru Welsh Water Definitive Flooding List (DFL). They suffer from flooding from the combined sewer in events exceeding a 2 in 10 year event. One of the properties is subjected to Serious External Flooding (SEF), whilst the remaining 12 properties and the road suffer from Other Flooding (OF); there are no records of Internal Flooding in this catchment. The cause of the flooding is large volumes of surface water entering the combined sewer and overloading the sewer network. These flows mainly originate from roofs, with few areas of paved hard standing.



Introduction

The traditional solutions of pipe upsizing and storage would not provide the most beneficial solution for this catchment. Instead, a targeted catchment-wide survey was undertaken to identify areas where surface water could be removed from the sewer network.

The philosophy of this approach is that a reduction in flows in the extremities of the catchment would reduce surcharge levels and flooding from the sewers in all downstream areas. The solution included the separation of both hard standing and roof drainage from the combined network and providing water-butts to some 70 properties to attach to guttering downpipes. Overall, hydraulic modelling showed that these solutions reduced the risk of flooding to 1 in 20 years, with further storage provided by the water-butts giving resilience to a 1 in 30 year event.

Project background

Begelly, Kilgetty and Pentlepoir are a close conglomerate of villages within the catchment of Langdon WwTW. All of the villages are served by a combined sewer which join in Begelly and flow via a combined sewer overflow (CSO) to the works. The combined sewer receives surface water flows from both roofs and paved areas, although throughout the 70ha catchment, the road drainage is fully separate and many roofs are separate and discharge to the stream or moor.

There has been a history of flooding for many years. Six properties and a road listed on the DFL are located at Kingsmoor Close in Pentlepoir. All of these flooding properties are classified as OF. Pentlepoir is located on the southern fringes of the catchment close to the A487 going to Tenby, and south of the A477.

A further four properties are located on New Road, Begelly. These are spread along the whole length of the road, which is also the route of the main combined sewer. One of these properties is classified as SEF. The remaining two properties are located on the A478 going to Narberth. These are located at a much higher elevation than those along New Road and in Kingsmoor Close.

During the initial site visits and survey the team spoke to the residents of the flooding properties at Kingsmoor Close. They reported large quantities of clear flow that was powerful enough to lift and rattle the manhole covers. They said that the only way to protect their properties was to take the cover off themselves and allow the sewage to flow away into the adjacent moor.

They suggested that there had been some improvement over the previous couple of years because of the upsizing of the two downstream lengths of sewer. However, they were keen to stress that flooding was still a regular occurrence. They also stated that they had issues with fat and grease in the sewer.

The clear flows evident in the sewers and a large storm response, dictated that surface water removal should be the prime area to be investigated in order to find a solution. Furthermore, a relatively small flow to treatment at Langdon WwTW and limited storage capacity before spills to the River Cresswell validated this investigatory path.

Hydraulic modelling and site survey

Site survey was undertaken across the whole catchment to help gain a better understanding of the mechanisms of the flooding at each location. Manhole cards and surveys of key assets helped confirm the invert and cover levels used in an existing hydraulic model were correct and reliable. CCTV of the main sewers helped assess the condition of the existing sewers and location areas of infiltration.

A flow survey was commissioned in order to verify the model and help pinpoint the sub-catchments contributing major volumes of surface water to the sewer network. The flow-depth-velocity (FDV) graphs were analysed to assess the level of infiltration entering the sewer. The flow response to rainfall verified that surface water was the main problem in this catchment.

A connectivity survey was undertaken in order to try and locate the contributing surfaces. This was based on the initial flow survey results and a detailed review of aerial photographs and Ordnance Survey plans.

The connectivity survey was chosen over a more traditional impermeable area survey (IAS) because the addition of the sewer layout on the survey plans quickly enabled the feasibility



GLOSSARY OF TERMS		
Definitive Flooding List	DFL	This is a list of properties within Wales at risk of flooding of the property or its curtilage from public sewers.
Internal Flooding	DG5	Foul, combined or surface water sewage escapes from a sewer into a property, enters a building or passes beneath a suspended floor.
Serious External Flooding	SEF	Access to premises cannot be achieved without stepping through sewage flooding, the garden is extensively flooded leading to its effective destruction or outbuilding and non-integral garages are flooded inside.
Other Flooding	OF	Less severe than SEF and does not affect roads of 'A' or higher classification.
Surface Water Eradication & Removal	SWEAR	A Welsh Water term relating to a scheme where surface water is removed from the sewer network.
SuDS		Sustainable Drainage Systems

of a SWEAR scheme for a specific location to be assessed. The contributing surface areas were checked manually for each of the sub-catchments in the hydraulic model.

The flow survey highlighted that whilst there was infiltration within the catchment, its effect on the flooding was negligible. Road drainage was determined to be fully separate, which immediately indicated that surface water removal would become increasingly difficult.

The connectivity survey showed that the vast majority of the contributing area was individual property roofs, interspersed with some commercial and council property. The Langdon catchment is rural and relatively affluent, with the majority of properties being detached houses. Retrofitting SuDS solutions to the number of properties required to solve the flooding problem was not feasible within the project budget. However, the commercial property and council owned properties presented an opportunity to undertake some surface water removal.

One problem that was made clear on a site visit was that an existing CSO, designed to protect the properties on New Road, was ineffective. Flooding was taking place whilst the flow in the outfall pipe was at one third bore.

The properties on New Road sit marginally higher than the CSO cover level, indicating that there was a large hydraulic gradient to the upstream manholes, and therefore the sewer was under-capacity for the current flows.

In addition, the actual outfall was below the water line of the swollen river. If the river levels had become any higher, the CSO would have become river locked. It was clear that the solution would have to ensure that flows could get to, and out of the combined sewer overflow.

Options

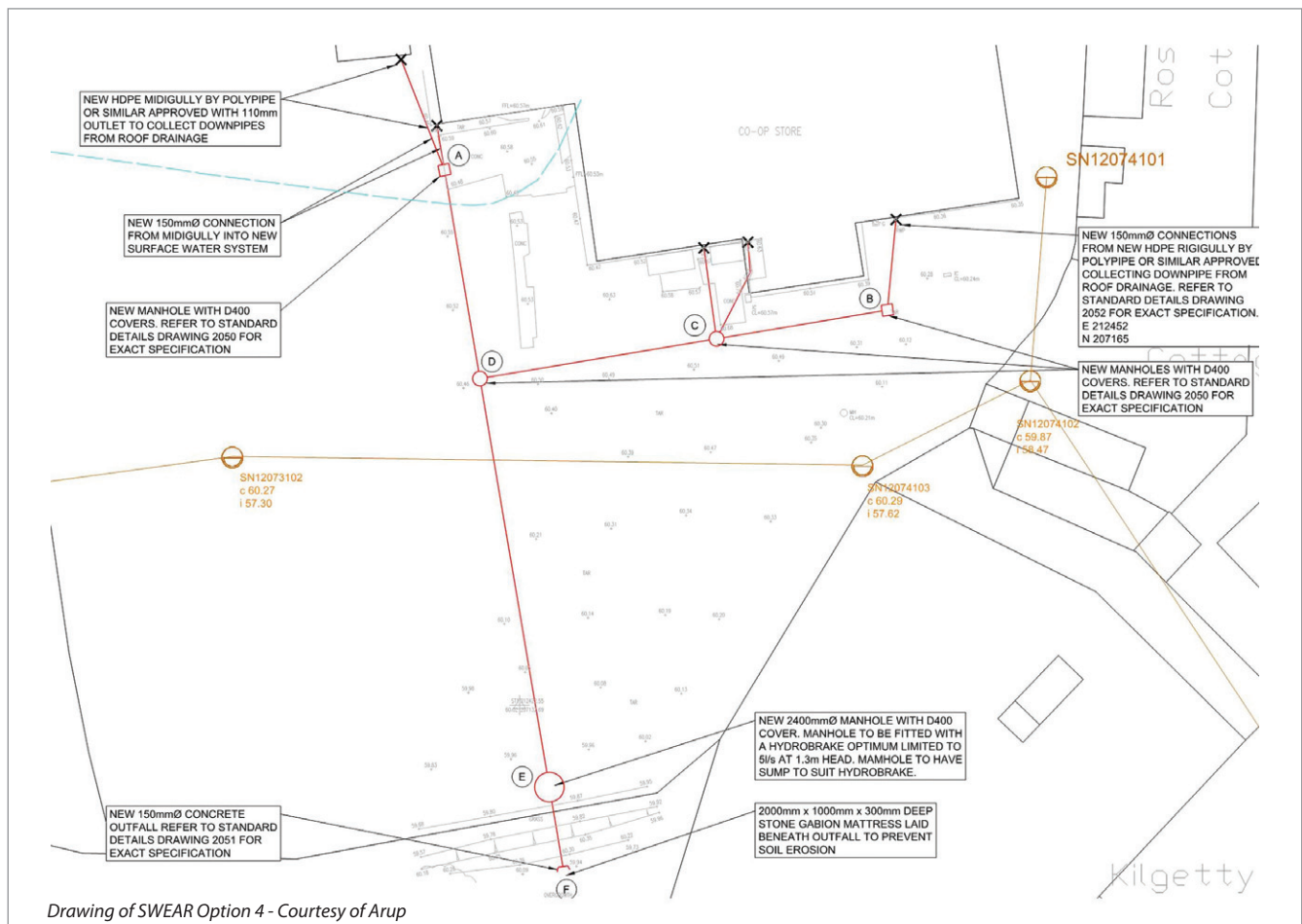
A total of five areas within the catchment were identified as being suitable for SWEAR schemes.

These were as follows:

- **SWEAR 1:** Removal of roof drainage and playground of a disused school contributing a significant flow directly upstream of the flooding properties at Kingsmoor Close.
- **SWEAR 2:** Removal of a tarmac parking area within a large caravan park which was drained by gullies connected directly into the foul sewer upstream of Kingsmoor Close.
- **SWEAR 3:** A partial removal of roof drainage on 20 properties of a residential estate by taking the flow to the road gullies. This was again upstream of Kingsmoor Close.
- **SWEAR 4:** Removal of the roof drainage of a supermarket. The proposal was to pipe the flows through the car park and discharge into the moor.
- **SWEAR 5:** Removal of a significant roof area from a large public house and associated accommodation which would be piped into the local river.

Despite these surface water removal works the hydraulic model showed that the sewers immediately upstream of the CSO would still be under-capacity. This sewer would have to be upsized and a pumped element added to the CSO in order to ensure its effectiveness and protect the properties on New Road against flooding.

With all of the elements combined, the protection against flooding was the required 1 in 30 year event for OFWAT to sign off the



scheme. However, it was evident that not all of the SWEAR elements could be incorporated within budget. A matrix was produced to show the return period protection for various combinations of SWEAR removal.

The initial route to follow was to omit SWEAR 3 because of the cost and difficulty of individual property removal. Following a precedent set for a previous Welsh Water scheme, a 1 in 20 return period could be achieved and signed off when water butts were issued to properties with roof drainage discharging to the combined network to provide additional storage.

Problems to overcome

One of the aspects of SWEAR schemes is that, unlike works to a foul sewer, Welsh Water do not have any rights to undertake surface water removal works, therefore, notice cannot be served to gain access. All construction must be through agreement with the land owners, which can become protracted when they are not necessarily the people that will benefit from the scheme.

There had been historic flooding problems associated with the River Cresswell leading to the local county council initially being very reluctant to allow any discharge to the watercourse. Unfortunately, the local geology is not conducive to soakaways, ruling out that method of removing the flows. This was despite many properties having them constructed to take flows from their downpipes. Compliance with the requirements of the local county council for storage for a 1 in 100 year plus 20% event, and a restriction of discharge to 5 l/s would add significant cost to the SWEAR schemes.

Solution

The solution that has been designed is a combination of SWEAR schemes to reduce flows and a further section of upsizing at Kingsmoor Close. Due to the challenges described above, not all of the SWEAR opportunities could be progressed. However, the

surface water reduction that will take place is a benefit to the catchment. The scheme is due to be on site for the construction phase in October 2013.

Added value

The catchment-wide approach enabled the solving of flooding at three distinct locations to be solved in one scheme. These three locations were originally due to be three separate schemes. Welsh Water carried out a public engagement exercise and is in close contact with the concerned residents and local councillors throughout the various stages of the design. This was primarily to alleviate their worries. They were thankful for the public exhibition, which was well received.

Conclusion

The catchment-wide approach to flood prevention, combining targeted survey and analysis produces a scheme that provides benefits throughout the catchment. This approach allowed the scheme to involve the removal of surface water, which deals with the problem of flooding at the source. A narrower focus around the flooding properties would have necessitated large scale sewer upsizing.

Key participants	
Client	Dŵr Cymru Welsh Water
Design engineer & hydraulic modeller	Arup
Contractor	Morgan Sindall plc

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