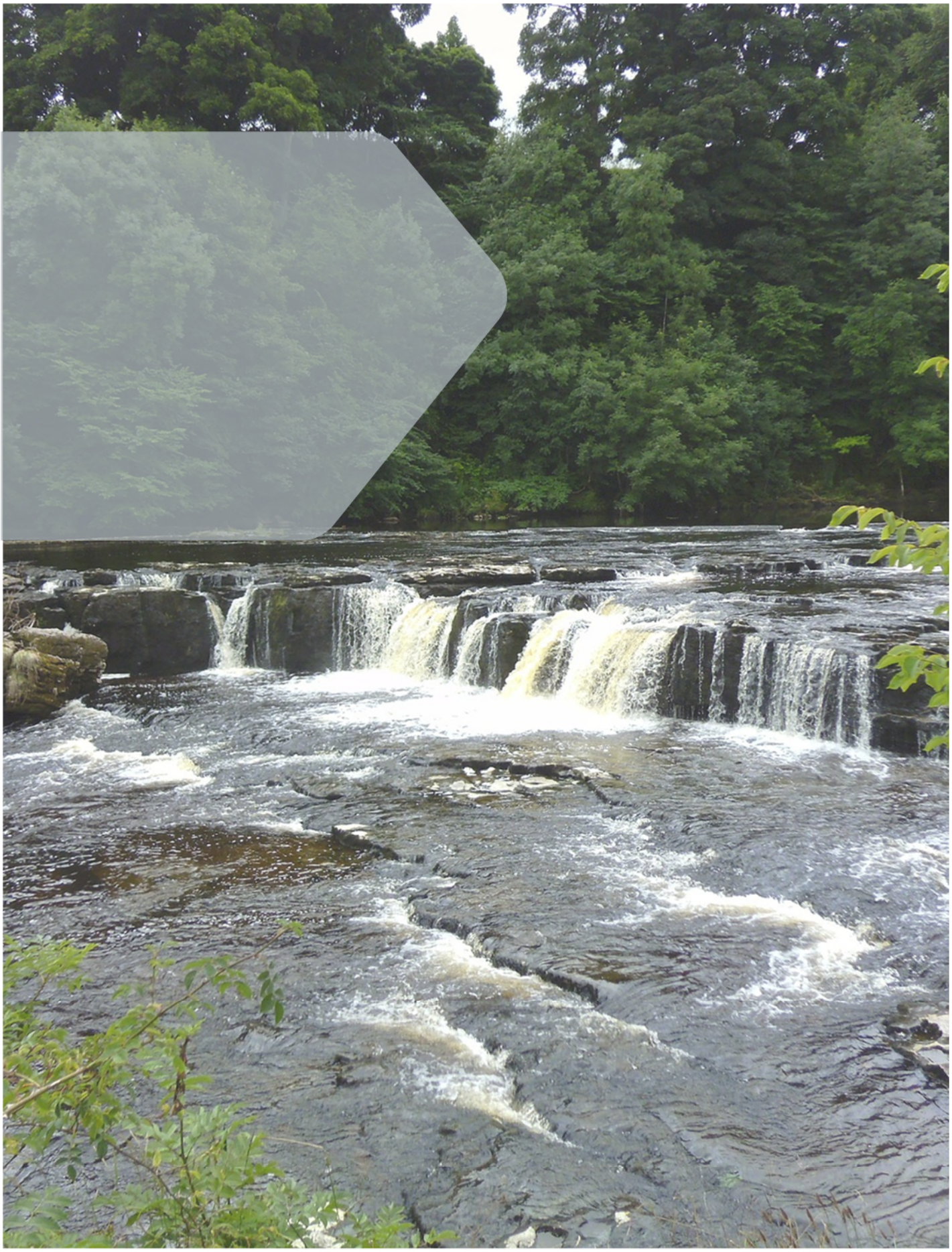
SWARCO

Flood Warning Scheme in a Rural Setting

The role of ITS in improving quality of life through a Flood warning system in the Yorkshire Dales National Park



Introduction

Flooding has been a long-standing and increasing problem for North Yorkshire County Council (NYCC) as well as residents and visitors to Wensleydale. A particular stretch of the A684 between Bainbridge and Wensley is often affected by flooding due to its location close to the River Ure and its flood plain.

According to data recorded by the Environment Agency, there is a risk of flooding to low-lying land, including the affected stretch of road, once river levels hit 2.5m at the monitoring station on the Ure at Bainbridge. On the 4th of November 2020, the chart below shows that water levels reached 4.08 metres after rainfall that would usually be expected throughout November fell in a 24 hour period as the UK experienced the tail-end of Hurricane Zeta. Local fire and rescue services had to rescue 9 people from vehicles after a lorry and 5 cars became stranded in the flood waters on the A684 at Wensley.

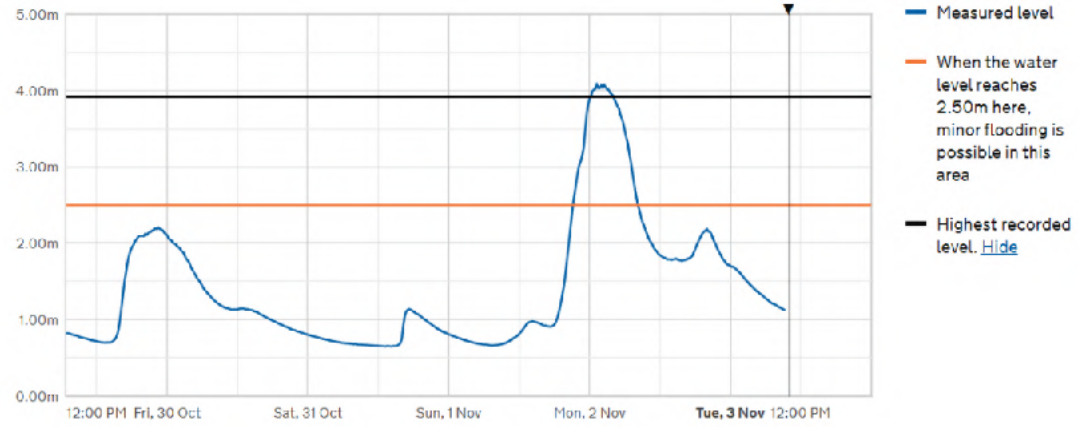
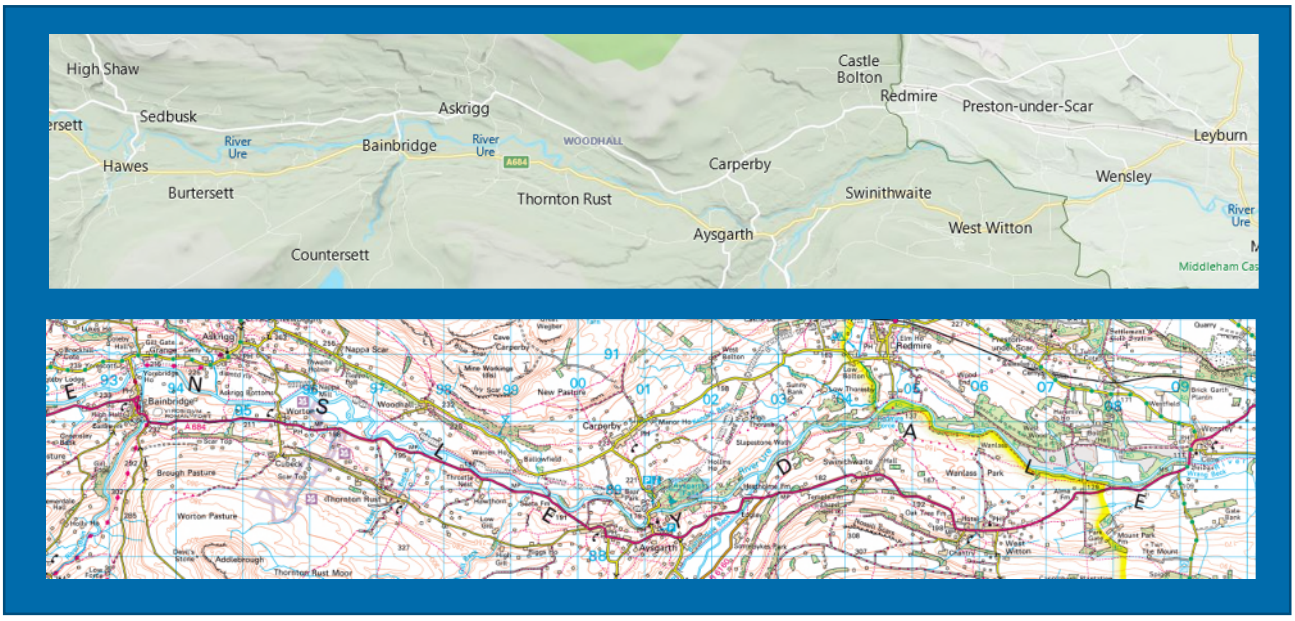


Image: Environment Agency

Location

Wensleydale sits at the heart of the Yorkshire Dales and is famed for its scenery and cheese. Wensleydale is home to the River Ure which flows from West to East, eventually meeting its neighbour, the River Swale, which becomes the Ouse and then heads toward the Humber Estuary via York.

The two map segments below show the area of concern, between Bainbridge and Wensley, in some detail.



Bing Maps / Ordnance Survey

A flood warning system for drivers had previously been explored as an option by North Yorkshire County Council (NYCC) but the necessary funding wasn't available at the time. Currently, when flooding occurs, NYCC rely on members of the public to inform them of the event. Response to a flooding event is therefore limited to office hours. Only once NYCC have been informed can they attend site and manually deploy signage to inform the road users of the situation using one of the existing plate signs pictured below.

In 2020, as part of its Safer Roads Fund initiative, North Yorkshire County Council finally had funding available to proceed. The aim of the scheme is to reduce incidents better informing road users of flooding and resulting road closures in a timely manner. The scheme addresses this through automating the system which will detect the flooding and inform road users and other stakeholders of the road closure through Variable Message Signs and an email notification system.

The initial scope outlined by NYCC included a requirement for 4 flood detection cabinets and 7 full colour RGB Variable Message Signs. To save power, reduce light pollution and avoid disturbance to residents, the VMS feature above ground vehicle detection that can be used to prevent sign activation unless a vehicle is detected approaching the sign location.

Developing the Scope

Site Surveys

Site visits by SWARCO's Project Manager, Brian McFarlane, were carried out to investigate the proposed locations for signs and cabinets, resulting in a number of changes. Some changes were made as a result of getting advice from local residents, some to locate equipment where it will be less visually intrusive, and, wherever possible, mains power has been utilised.

The flood detection cabinets, by their very nature, need to be tall so that the electronics components can be kept clear of flood waters. The cabinets themselves are painted green and have been sited to minimise visual intrusion.

Sign and cabinet locations are also partly determined by the fact that roads in Wensleydale tend to be quite constricted (narrow) in places and maintenance access needs to be allowed for. Signs also need to be located on the A684 at points where drivers can make a decision to use an alternative route which runs along the north bank of the valley but which is subject to a 18 tonne HGV restriction at the village of Askrigg.

Some of the final locations were adjusted following advice from local residents and also from being able to see physical evidence left by recent flooding prior to the site surveys.

A survey of mobile communications availability was included so that the best provider could be used for the area, with Mobius selected to provide the SIMs.

Locations

Bainbridge and Worton

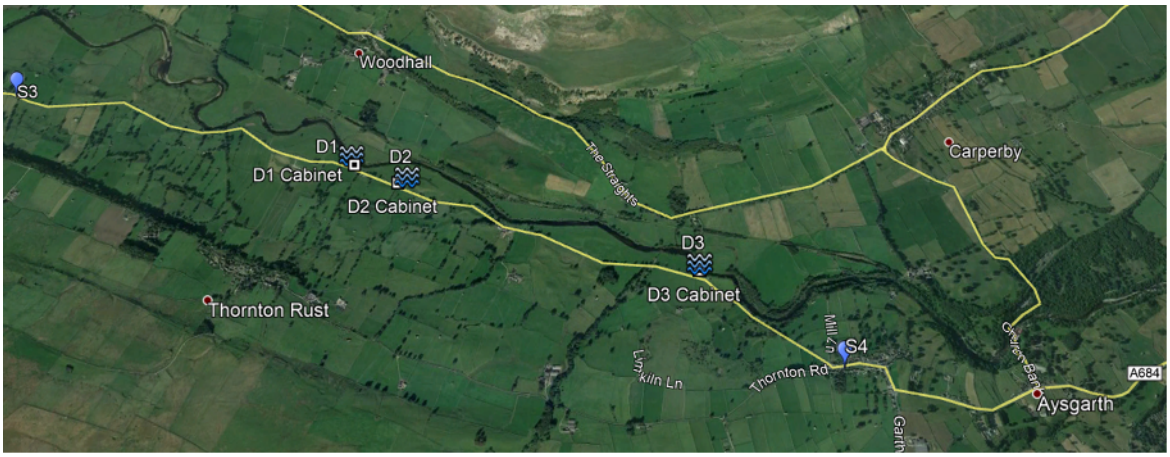
Image (and others) from GoogleEarth

Flood warning signs are located at the points marked S1, S2, S3 and S7 on the Google Earth view above, with a flood detection cabinet at D5. D5 is on a potential diversion route and floods when a small, often dried up, beck is affected by heavy rainfall and run-off. Sign S1, approaching Bainbridge from the west (i.e. from Hawes) activates when flooding is detected further downstream and is located to enable the alternative route via Askrigg to be used, though this road is not suitable for large HGVs. Sign S2 and S3 also activate for eastbound traffic when flooding is detected further downstream

Floodplain at D5:

The cabinet and flood detection pit for D5 are shown above, with the cabinet sited to minimise its visual impact.

Worton to Aysgarth



Moving downstream (eastward), the view above shows the location of flood detection cabinets at D2, and D3; all locations known to cause flooding problem, as shown by the image below of a delivery wagon making its way through the November 2020 flood on this stretch of road. The sign at S3 will alert eastbound drivers of flooding along this stretch with Sign S4 warning westbound drivers.

The same location during fine weather.

This is also the location of flood detection site D1

Wensley area

Further downstream where the A684 crosses the Ure at Wensley is a point notorious for flooding. This is now protected by signs at S6 (for westbound traffic) and S5 (for eastbound) which are activated when flooding is detected at cabinet D4. The potential diversion route heads north out of the village of Wensley before reaching the river.

The images below show flooding at the D4 location in November 2020


Image: YorkshireLive

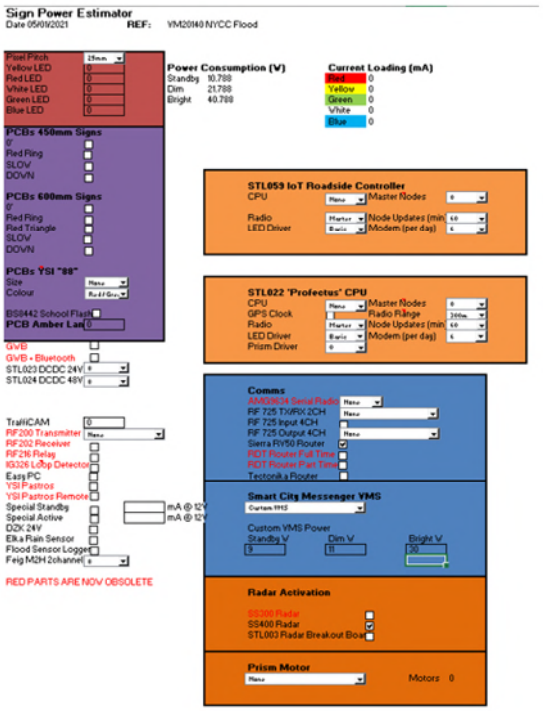
Image: RichmondshireToday

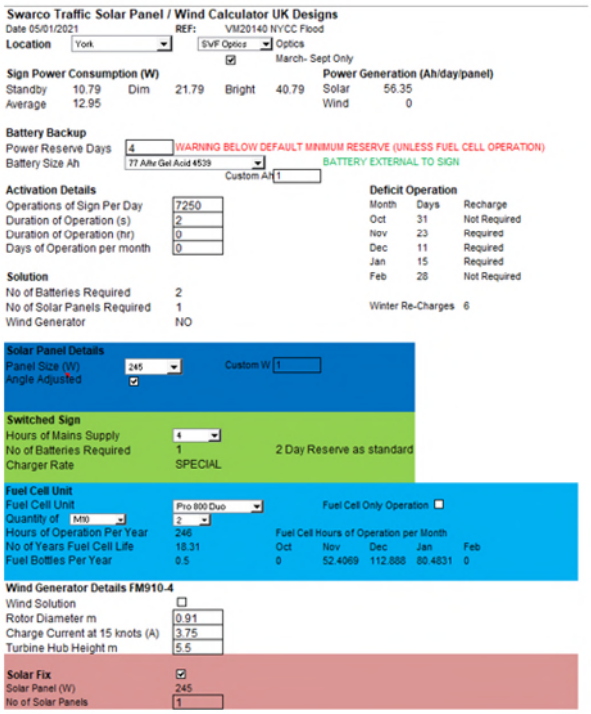
Technology Used

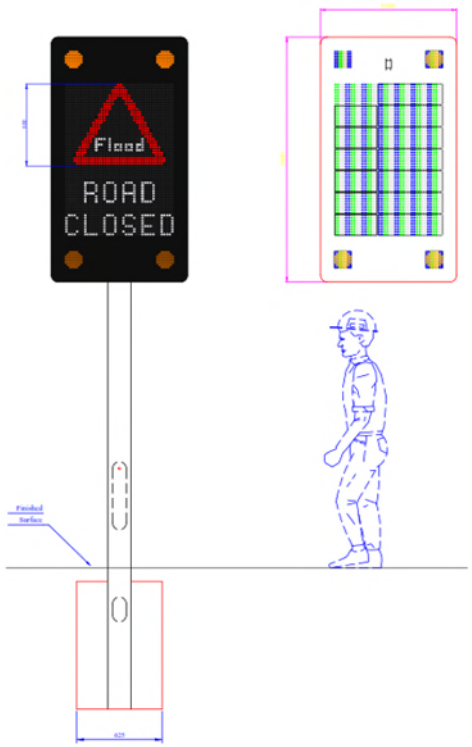
Site survey information and traffic data are used to calculate the expected energy consumption of the VMS. This is then used to determine if solar or wind power solutions are viable for each site. At SWARCO we have developed our own calculator tools for this:

Type [RGB/W/Y]:	RGB	full colour	DC		temperature class:	T1-T3		Percentage of LEDs ON for max. power consumptio	50 %
Pixel:	width= 40	800 mm		height= 56		1120 mm		LEDs typically active when using a average messag	30 %
Primary LED-boards [24x8]:	7			DC/DC: 2				Intensity for calculation of typ. power consumptior	15 %
Sekundary LED-boards [16x8]:	7			Min suggested DC/DC: 2		Boards/ DCDC: 7		Consumption of DC/DC in standby mode:	2,6 W
Pixel pitch[mm]:	pp= 20			active Area [m²]= 0.90		pow./DCDC: 15 W		No. and Consumption of Controller: 1	2 W
Total operating current per pixel [mA]:	I= 5.76			9.6 ft²				Fan:	W
				max. rating DC/DC[W]: 60				Heating:	W
Luminance[cd/m²]:	L3(*)							twilight dimming level:	30 %
Luminance ratio:	R3							night dimming level:	2 %
Beam width:	B6							Optic / designation:	3G6
Colour:	C2								
Maximum Luminance white [cd/m²]:	La= 16,284 cd/m²								
Luminance ratio value (white):	LR10= 32.4								
Operating Voltage:	VDC= 5 V								

	Power consumption [W]				Energy consumption [kWh]			
	Maximum [W]	Standby	Typical@24h	Standby	Typical day	Typical twilight	Typical night	Standby
	ALL Pixels ON with full intensity, @16284 cd/m² white, incl. 4x125mm Flasher	ALL Pixels OFF bet full functionality on commuication, incl. 4x125mm Flasher	50% Pixels ON with 15% intensity, @2443 cd/m² white	ALL Pixels OFF bet full functionality on commuication	30% Pixels ON with full intensity @16284 cd/m² white colour, average consumption of VMS, incl. 4x125mm Flasher	30 % pixels ON with 30% intensity @ 4885 cd/m² white colour, average consumption of VMS, incl. 4x125mm Flasher	30 % pixels ON with 2% intensity @326 cd/m² white colour, average consumption of VMS, incl. 4x125mm Flasher	ALL Pixels OFF bet full functionality on commuication, average consumption of VMS, incl. 4x125mm Flasher
P[Led]	65		5		20	6	0	
P[cc]	5		4		3	3	3	
Controller	2	2	2	2	2	2	2	2
Fan								
Heating								
Temporary consumers								
4x125mm Flasher	6.0	6			6	6	6	6
Power supply				1				1
Total	78	8	11	3	30	17	11	9
Average working hours per day [h]:					7	6	6	5
Energy consumption [kWh]:					0.21	0.10	0.07	0.05







Signs a have a full matrix area to enable future setting of messages which are not flood related, providing further flexibility of the solution.

Image showing signs designed to fit within the space available on verges and minimising visual intrusion when not in use.

Control Cabinets

The VMS cabinets house batteries to power the signs with a fuel cell generator to maintain voltage (located at the bottom of the cabinet) and are also powered by a solar panel where possible. Flood detection cabinets also feature a similar layout.

Inside a control cabinet

Inside a flood detection cabinet

Detecting Flooding

Flooding is detected by Sick pressure sensors housed in subterranean chambers. These not only fill with water during flood events but become submerged under the standing water. The Sick pressure sensors have a transducer which converts water pressure into a 20mA analogue output. The typical car park outstation has been adapted to monitor this sensor and convert the water level into a car park count.

Using the UTMC car park count outstation interface this water level is transmitted to the central system. With no water pressure, the detection reports “Spaces”. The next threshold, nearly flooded, reports “Nearly Full”, and “Full” is reported when flooding is happening. The pressure thresholds are related to the head of water above the sensor at the same height as the road surface and can be adjusted using SWARCO’s hosted management software.

The sensors are connected to a control and communications cabinet which is located nearby and at height to avoid flood damage to the components. These are battery powered with fuel cells to keep the battery at the correct operating voltage. Each fuel cell is calculated to have sufficient fuel (ethanol) to operate for up to two years. Fuel will be topped up at each annual maintenance visit. Remote Monitoring will generate alarms should fuel run low between these visits.

Maintenance and support for the field equipment and the central management software will be provided by SWARCO for a period of 10 years, during which this ITS application is expected to save a lot of disruption and possibly lives.