## Ordinary Meeting of Harberton Parish Council Tuesday 14<sup>th</sup> November 2023

## Item 10: Flooding in Harberton Parish

Further to information shared with Parish Councillors with papers ahead of the Ordinary Meeting of 10<sup>th</sup> October 2023, please find additional information as follows:

- 1. Responses from the Environment Agency to questions from the Parish Council. This includes queries that arose from **Harbertonford** residents made via the digital survey above.
- 2. Screw Lane Update 5th November 2023 produced by Harberton resident John Culf
- 3. Forwarded correspondence from Flood and Coastal Risk Officer
- 4. The final report produced by Harberton resident Peter Cogley on flooding in Harberton.

All documents are compiled here in order for your reference.

## EA response: Harberton Parish Council enquiries following the 17<sup>th</sup> of September 2023 floods.

Event statistics – A comparison with December 2020:

## December 14<sup>th</sup> 2020 Flood rainfall:

Peak intensity 6.4mm per 15 min. This equates to 25.6 mm per hour. Total = 15mm in 1.5 hours



## September 17<sup>th</sup> 2023 flooding:

Peak intensity 14.199 mm per 15 min. This equates to 56.796 mm per hour. Total = 60mm in 2 hours.



## Summary

- The September 23 event had double the peak intensity to that of the December 2020 event.
- The September 23 event was 2 hrs in duration, the December 2020 event 1.5 hours.
- The September 23 event had prolonged intense rain compared to that of December 2020. This is illustrated by the dashed purple line on the bottom graph which shows that the Peak intensity of the 2020 event was sustained for 1.2 hours compared to a 15 minute period in 2020.
- We have calculated that the culvert capacity would have been exceeded at least 4 times during this event, irrespective of any blockage.

## Flood warnings:

### How our Flood Warning Service works

Our Flood Warning Service includes 3 levels of warnings:

- Flood Alerts which are issued for large areas and will usually be issued before Flood Warnings at these levels, flooding to low lying land, including some roads and gardens, can be expected.
  - These can be triggered off multiple gauges, but we do not have gauges on every watercourse within the Flood Alert area. Therefore, instances of localised intense rainfall may not always be detected in our gauge network.
- Flood Warnings which are issued when property flooding is expected to occur.
- Severe Flood Warnings which are issued in conjunction with the emergency services, only when there is widespread danger to life.
- It is important to note, that if a severe flood warning is not issued, there can still be the potential for danger to life all flood water is dangerous.
- Anyone can sign up to our Flood Warning Service to receive notifications via phone, text or email.
- •

#### **Our Flood Warning Service in the Harbourne catchment**

- People living in flood risk areas from the tributaries of the River Harbourne can receive a Flood Alert for the *South Devon Rivers*. This alert warns when flooding is possible and we want people to start taking steps to reduce their flood risk. Our alerts cover large geographical areas which are shown on our website.
- People at risk of flooding from the River Harbourne can also register for the full flood warning service. This means they can register for Flood Alerts and Flood Warnings. Flood Warnings are community based areas for example the *River Harbourne at Harbertonford*. Flood Warnings are used to warn customers that flooding is expected and they should take immediate action to protect themselves and/or their property.

## **Other Resources**

Please be aware that, in addition to our online flood warning information other flood risk information is available, which includes:

- The flood risk for the next 5 days <u>Find location Check for flooding GOV.UK (check-for-flooding.service.gov.uk)</u>
- Environment Agency <u>River Levels on the Internet</u>
- MET Office <u>Weather Forecast</u>
- Sign up to Met Office Alerts Guide to email alert service Met Office

## Screen telemetry:

The telemetry associated with the screen on Moreleigh road is currently powered by a battery and has been operational for a couple of years. Unfortunately, the alarms on the night of the event did not trigger. We have been in contact with our hydrometry and telemetry teams to understand why this occurred, when previously they had been operational. We understand that there was an update

to the operating system for the site which unknowingly disabled the alarms. We have been assured that this has been rectified and the alarms are now working.

The idea around the telemetry not being connected probably arises because there is a plan to upgrade the site to mains power. The mains power has been run to the cabinet, but we are waiting for the meter to be installed and the site commissioned. This will allow us to upgrade the camera. Once complete the site should have less issues around loss of operation. The meter installation is planned for this month and the site recommissioning soon after.

## Moreleigh road & A381 culvert capacity:

The culverts that discharge the Yeolands stream, back into the river Harbourne, run under Moreleigh road and the A381. These are known to be small (thought to be able to convey  $1 \text{ m}^3/\text{s}$ ) and unable to cope with flood flows. There is a provision for overland flow route over Moreleigh road through the gardens and back into the river, but this also only has a certain capacity. The combined result is that during flood events water pools in Moreleigh road which raises to a level that floods properties. To some extent properties are protected by property level resilience measures i.e. flood boards.

## Screen improvements project:

The screen improvement project carried out following the December 2020 floods had the following objectives and limitations.

## **Objectives:**

- Compliance with the updated 'Culvert, screen, and outfall manual' Ciria guidance.
- Increase the screen area available for debris management.
- To provide some small improvement to the overland flow route through the provision of new gates which would allow for some additional flow conveyance and reduce blockage risk.
- To improve the telemetry associated with the site.
  - Addition of alarms to alert the Flood Incident Duty Officers and the community. None were present previously.
  - To upgrade the site to mains electricity to improve telemetry resilience (not yet complete). Mains electricity is installed but the meter and commissioning of the equipment is still pending. The meter is due to be installed this October with the commissioning to follow shortly afterwards.
  - To upgrade the camera to provide more relevant timely images (not complete relies upon mains power)

## Limitations:

• This project would not improve the capacity of the undersized culverts or change the current arrangements. This would be a much larger scheme and require a full business case.

\*Note: The limitations of the project were made clear to the community and parish council.

## What we are doing and can do going forward:

## Short term

- We have checked and reset the existing alarms at the screen.
- We are gathering data to help with analysis. We will be attending the community drop in session in Harberton on the 17<sup>th</sup> of October.
- We are about to install the meter and commission the screen telemetry for a more resilient mains powered solution.
- We will be meeting with partners and the local council to understand review what may be possible. Date TBC.

#### Medium / Long term

- We can look at maintenance options.
- We are looking at an additional rain based alarm from a near by rain gauge that will provide additional resilience to the alarm network that feeds into the Flood Incident Duty Officer.
- We will be exploring if there is a possibility of doing a more complete project to improve standard of protection offered to the community. Please be aware this can take a while to complete.

Where a large investment is required to promote an improvement scheme we must follow the government rules on spending and it should be understood that there is no guarantee that any scheme considered will be eligible.

### Natural flood management fund – Expressions of interest:

We understand that Devon County Council are making an expression of interest for Harberton.

## Email Queries - Harberton Parish Clerk

It would be very useful to have direct information from the Environment Agency to report to the Parish Council about the flooding event in Harbertonford - particularly after recent works on the culvert. There are rumours that the warning system hadn't yet been connected to a power source and therefore not operational - so it would be useful to have an update on the truth of this.

## EA Response: Please see section titles 'Screen telemetry'

I'm attaching a document that I've prepared for the Parish Council, that has responses from residents in Harbertonford and Harberton about recent flooding events. You'll see that a member of the public (Mr Cogley) has forwarded a report that he'd prepared on the flooding event in Harberton which is amongst those papers. The report implies that Mr Cogley is in contact with the Environment Agency himself as his report includes a space for a report from EA. I was wondering if this was in your patch or if there is a specific colleague of yours looking at the issues in Harberton?

# EA Response: Harberton is on an ordinary watercourse and is within the remit of Devon County Council. The Environment Agency has a strategic overview of flood risk associated with watercourses classified as 'main river'.

I've also become aware of funding available for the Natural Flood Management programme, and wondered about making an expression of interest relating to the issues seen in Harberton on 17th September. If there is anyone at EA able to discuss this that would be helpful.

#### EA Response: Please see 'NFM section'

#### Public responses to digital survey

## The following roads or areas of land were reported as having been affected by flooding:

- Where the A381 meets the Moreleigh Road in Harbertonford
- Pear Tree House, Harbertonford My driveway ponded (like I've never seen before) and the ditch in my garden filled (like it does in winter sometimes) but very minor. All drained by sunrise.
- The Melbray, Harbertonford TQ9 7TS water filled the garden and made it to the top step at the rear door but did not enter the property. The garden filled with mud and water. We now have an issue that the gravel in the garden is on concrete and has mud underneath it. This means that when it has subsequently rained the garden is a mud bath and the car gets stuck. I am not sure how we resolve this as the mud has nowhere to go.

## EA response: N/A

## Please let us know any further information that you think would be relevant to share with Devon County Highways, Devon County Flood Team or the Environment Agency about the flooding event:

• The culvert doesn't work. The road drains aren't big enough. I have videos of the road before, during and after the flash flood The drain at the front of the house was left blocked in the clean up by the environment agency

#### EA response:

Please see section 'Moreleigh road and A381 culvert capacity'

Road drains are generally not the responsibility of the Environment Agency however, we would welcome the evidence that has been gathered for review and our records.

#### What kind of support do you think that people in the community were able to provide that was useful, both during and after the flooding event?

- 1. Neighbours helped each other to clean up their flooded houses.
- 2. Local help
- 3. After the flood locals were very helpful in clearing the affected houses
- 4. There was no warning, no immediate support to evacuate residents. The environment agency were only concerned with the road and offered no help to home owners. There was no offer of support or accommodation from the council. There has been no information about what went wrong or why the new system failed us

EA Response:

#### 1, 2 & 3. N/A

#### 4.

Please see sections 'Flood Warnings', 'Screen telemetry', 'Culvert capacity' & 'Screen improvement project'

In response to "The environment agency were only concerned with the road and offered no help to home owners" We provided the support we could resource. We cleared the overland flow route on the road to keep it clear for further floods and we also cleared a wider road area including some of the residents steps. The ongoing flood event required that our resources were required to provide incident response elsewhere within Devon.

#### Is there anything else that could have been useful to help prepare for flooding, or help clean up afterwards? How might the community be better prepared in the future?

- 1. Obviously a better water route for the culvert. A warning system that actually is operational. The council could actually spend time cleaning away the silt from the roads affected, so that residents don't have to constantly deal with this being tracked back into their homes once they have been cleaned. The highways could empty the drains, now full of silt, posing an even greater threat to future flooding
- There needs to be proper flood defences.
  The EA flood defences could have been working. Ie the culvert and the pump.
- 4. If the same was to happen this weekend we would have the same result. What is the plan for this?

#### EA Response:

- 1. Please see sections 'Screen telemetry' & 'What we are and can do going forward'. We aren't responsible for day to day road and drain clearance.
- 2. Please see section "What we are and can do going forward" with regard longer term solutions and the requirements for this.
- 3. The culvert is not the responsibility of the Environment Agency this is a third party asset. The Environment Agency operated and maintained assets along the Yeolands stream are limited to the screen and its structure. We have no fixed pumps in this area, we would like to understand this statement further. Is there any more information that can be provided?
- 4. Please see sections 'Event statistics', 'Moreleigh road & A381 culvert capacity' & 'Screen telemetry'.

If an event of this scale were to happen again it is very likely that flood water would overwhelm the culverts at Moreleigh road and lead to similar depths of water in the road. Flooding ensuing from this relates to the property level resilience measures, their deployment and effectiveness.

The alarms at the screen have been reset and so should trigger an alert to the community from the Flood Incident Duty Officer at the environment agency and potentially the deployment of the field teams.

#### Is there anything else you'd like to say?

- 1. Why was the EA camera and warning system not activated on the culvert? Why has the council not installed proper drainage systems that can cope with these conditions? Why has no one from the council come to clean up the road silt, mud and branches? We as residents have missed work time to do this. What on earth are we paying the council and government bodies for if they don't do their jobs!
- 2. For two years we've had work at the back of our property, been inconvenienced by road closure. A bus has hit our garden wall due to the road works and a lorry hit our house. I would like an explanation of what work has been done, what it should have done and why it failed. I would like to know what the plan is from all agencies to avoid a repeat incident. I would like to know from each agency what their statutory duties are for these incidents and what their response was.
- 3. When I heard the rain and saw the puddles in the night I checked the gov website (https://check-for-flooding.service.gov.uk/) and it said no flood warnings, so I went back to bed. I hope the poor people in Harbourne Terrace do not rely on this resource. Seems strange that it would not even say "flooding is possible", even while several houses were under water. Maybe it only covers predictions of river levels (the Harbourne, which is at the end of my garden, was not exceptionally high, throughout) and it was incoming streams problematic in this case, which it does not cover? Would be good to understand this better.

#### EA Response:

1. In response to "Why was the EA camera and warning system not activated on the culvert?" please see section 'Screen telemetry'.

In response to "What on earth are we paying the council and government bodies for if they don't do their jobs!". We, at the environment agency, are sorry you feel let down by our service. We have powers, but no statutory duty to undertake flood defence works and we must work within the government spending guidelines to ensure a consistent and proportional allocation of funds.

2. Please see sections 'Event statistics', 'Screen telemetry', 'Screen improvement project' & 'What we are and can do going forward'.

In response to "For two years we've had work at the back of our property, been inconvenienced by road closure. A bus has hit our garden wall due to the road works and a lorry hit our house."

We are sorry to hear of the inconvenience caused by the screen improvement project. As best we could the local council and community were consulted about this disruption and efforts made to keep this reduced to a minimum. While the work occurred over two years (Design through to construction) there were only a few weeks where the actual road was closed or impacted during construction. We were unaware of the incidents highlighted; please can more details be provided so we can discuss this with our contractor? As far as we understand all standards and compliance requirements were carried out for the road works.

In response to "I would like to know what the plan is from all agencies to avoid a repeat

## incident."

Please see section 'What we are and can do going forward'

Additionally, if an event of this scale were to happen again it is very likely that flood water would overwhelm the culverts at Moreleigh road and lead to similar depths of water in the road. Flooding ensuing from this relates to the property level resilience measures, their deployment and efficacy.

The alarms at the screen have been reset and so should trigger an alert to the community from the Flood Incident Duty Officer at the environment agency and potentially the deployment of the field teams.

In response to: "I would like to know from each agency what their statutory duties are for these incidents and what their response was".

Generally, the Agency does not have a duty or liability to stop or reduce all flooding. The Agency's flood risk management powers (Section 165 Water Resources Act 1991) to carry out flood risk management works including maintenance to manage flooding from main rivers are permissive in nature and not a duty. Using these powers are subject to 2 conditions: (1) that the Agency considers the works desirable in accordance with the Agency's strategy (national flood and coastal erosion risk management strategies under sections 7 and 8 of the Flood and Water Management Act 2010) (2) that the works are to manage a flood risk from main rivers or the sea.

In the case of the Yeolands stream we have and are putting in place several ways to improve resilience and warning. We increased the screen area in line with up-to-date guidance. We introduced new alarms to warn the community. We are upgrading the telemetry to mains power which will improve the resilience and allow us to improve the camera at the site.

On the night of the 17<sup>th</sup> we attended the area and supported in the clear up of debris from the road to maintain the overland flow route. We prioritise incident response to areas depending on resource and risk, as such we cannot guarantee that we will attend every flood event.

3. Please see section 'Flood warnings'

## Harberton Screw Lane 231105 Update

The purpose of this update is to report on my observations of land drainage / runoff over the last couple of days (**when there has been relatively little rainfall**) from the 4 fields immediately to the N of Screw Lane, the detrimental effects this is currently having, and the worrying possible consequences if nothing is done about the present situation.

**Practically all the visible runoff (in occasional showery rainfall conditions) is coming ONLY from Field 1.** This description is not intended to apply to heavy rainfall conditions, although it would seem reasonable to assume that runoff under such conditions might well also be greater from Field 1 than from Fields 2 and 3.

Open the thumbnailed map below in a separate window (1200x900 pixel size, or print this) to use as reference with the illustrated description below.



The file names of the following individual images include their date and time stamp.



4) Road clearance initially by farmer and later by DCC a few days after the 17/9 flood was mostly dumped inside GW1	5) Blockage of a pipe under the road is still causing a lot of runoff from Fields 1 & 2 to appear on the right in this photo and flow down the road	<ul><li>6) The rest of the runoff from Fields</li><li>1 &amp; 2 is now diverted westwards by</li><li>the initial flood deposits</li></ul>
7)to flow along behind the hedge bank in Field 4 where a	8)huge deposit of soil has built up. The next image is taken through the hedge gap approx. 1/3 in from the left edge of the photo	9) This is almost opposite where the open ditch passes through a buddle hole into Tristford Farm Orchard
10) A few metres further to the W, where the silting ends, the water flow pools and runs through the hedge bank (see photo 12)	11) Meanwhile, at the same time, there is no runoff flow through GW2 from Field 3	12) Water flowing through hedge bank on left from Field 4 into Screw Lane
13) A combination of water seeping through the hedge bank from the saturated silt behind, water running down the road from the blocked pipe, and the road water getting constantly splashed against the bank	14) has caused a significant collapse of bank soil into the road over a length of some 10 metres. With a huge weight of saturated soil behind the hedge bank	15)there is a <b>possibility of</b> <b>complete collapse of the hedge</b> <b>bank</b> , which would block the HGV route around Harberton and cause great inconvenience

As well as the pipe under the road being blocked, the open ditch remains heavily silted up, forcing a lot of water to flow down the road (and continue along the road until it reaches the twinwall pipe through the S hedge bank

into the Orchard, which pipe continues to function well following effective clearance and re-grading of the outflow in the Orchard); this flow down the road is also threatening to further erode the edge of the road beside the open ditch.

The large volume bank collapse photographed on 2/11 (see 13 above) was already less obvious to the observer on 3/11 as much of it had been washed away / spread over the road by the constant stream of water on the road in this area and by the action of passing vehicles (including heavy vehicles).

The pipe under the road and the open ditch must be properly cleared and sufficient dumped material inside gateway GW1 must be re-located to allow the normal runoff (mainly from Field 1, with a little also from Field 2), along with the normal land drainage from the 'spring', to reach the pipe under the road instead of flowing down the road and westwards along behind the hedge bank in Field 4.



Fwd: Harberton flood. Reality check. 1 message				
To: Harberton Parish Clerk <clerk@harbertonparishcouncil.org></clerk@harbertonparishcouncil.org>	7 November 2023 at 17:34			
C				
Useful correspondence for the PC				
Р				
Begin forwarded message:				
From: Jago Burrist Subject: RE: Harberton flood. Reality check. Date: 7 November 2023 at 15:04:32 GMT To: Richard Morris MRICS FAAV				

Apologies for the delay in responding. Storm Ciarán has been keeping us busy. Was Harberton affected by any of the weather last week?

The nearest rain gauge which I saved data from on the night of the flooding in September was Austin Bridge on the river Dart near Buckfastleigh (spreadsheet attached): https://check-for-flooding. service.gov.uk/rainfall-station/46103

This gauge measured a lower level of rainfall but still recorded over 40mm in two hours and over 10mm in one 15 minute period.

Using Harbertonford as a proxy for Harberton is not perfect, you can see the difference even between the measurements at the two Harbertonford locations so there is a lot of local variation.

Looking at the rainfall in the days before the event, there had been periods of rainfall but not huge amounts. An important factor would be the management of the land above the village i.e. compacted or bare ground, rather than the ground just being saturated. Without having monitored the antecedent conditions prior to the event this would be difficult to say. Additionally, screw lane and the fields below the lane would have stored some of the water so not all would have reached the village. The infiltration into the field below screw lane would also be different to the fields above the lane.

In terms of the volume of water, the calculation is correct for the area and the rainfall recorded but I wouldn't be able to say how much of this ended up in the village.

In regards to your previous email. Our team does receive enhanced flood warnings but we don't get the real time notifications from the rain gauges. The EA would get this information though.

I agree a rain gauge may be the best option for your situation due to the very flashy nature of the catchment. A culvert sensor may not provide a warning until too late. A rain gauge would, probably, give you some additional time.

Did you receive any response to the message in the village newsletter?

Many thanks,

#### **Jago Burris**

#### Flood and Coastal Risk Officer

Flood and Coastal Risk Management, Devon County Council

Room 120, County Hall, Topsham Road, Exeter, EX2 4QD

T: 01392 382203 Email: floodrisk@devon.gov.uk

Email Disclaimer | GDPR Privacy Notice

From: Sent: Thursday, November 2, 2023 11:01 AM To: Jago Burris Cc: Subject: Harberton flood. Reality check.

Jago,

I'm struggling to come to terms with my calculated volume of water on Sept 17th, particularly 4,500 m3 in 15 mins (the 17.3mm reading)

This has been regular 'pub talk' these last weeks 🍅

Although the maths is simple, the conclusion has 3 key assumptions;

1 The accuracy / calibration of the 2 rain gauges in Harbertonford. Was this order of magnitude recorded elsewhere locally?

2 That Harbertonford gauges can be used as a proxy for Harberton

3 The amount of absorption into already wet soil. How much of the calculated volumes actually arrived into the lower parts of the village? Did the 15 minute 4,500 m3 flow right off saturated ground?

Don't interrupt your work to answer this in any great hurry, but when you can, please give it a sensecheck. I'm a newbie to groundwater, so I find the numbers very high.



Austins Bridge-rainfall-data (1).csv

## **Harberton Flood**

# 17th September 2023



## 1 Purpose and scope

This document aims to;

- 1.1 Capture photographic information
- 1.2 Describe the flood flow path and its effects
- 1.3 List the precursors
- 1.4 Recommend mitigation for future events

1.5 Act as a reference for Parish and District Councils and the Environment Agency as input to their final report

#### Acknowledgements

The following are amongst many who contributed to this report;

Craig Penwarden

Jonathan Bean

Mark Norman

John Culf

**Cllr Richard Morris** 

Robert and James Rogers (Langham Farm)

Jago Burris and colleagues from the local authorities who provided information at the Harberton drop-in meeting on 17th October 2023.

## Changes

There have been multiple changes to the first, Oct 3rd, version of this document following the Harberton drop-in meeting on October 17th

Please use this version instead.

There will be no further changes. This is the final version. It has been passed to the local authorities as input to their report.

## 2 Harberton topography

Harberton sits at the confluence of streams from several valleys. The lowest contour point on Vicarage Ball, a few meters east of the culvert bridge, is 68 m above ordnance datum (AOD). The highest point is the trig point at the reservoir at 163 m. There is a 95 m rise over a point-to-point horizontal distance of just over 1 km (312 feet over 0.65 miles).

The OS map identifies a number of springs in the surrounding hills. Several streams converge into the final two streams entering Harberton from the north east and north west. These combine under the road, then flow south to Harbertonford.

This report concerns the north west spring and the stream flowing south east into the village only. Other parts of the village to the east and north were relatively unaffected.

The populated area is surrounded by farmland, both arable and livestock.

Screw Lane is a dividing line in terms of flow distance, relative gradients, and soil cultivation. It bisects the elevated terrain. It runs east/west roughly along a contour, 101 m AOD at Gills Cross in the east, 96 m at Belsford Mill crossroads in the west. It has a hump around half-way approx 20 m east of Threshing Barn's driveway. This hump was significant in directing the flow.

The total water stream path length in plan view is 1125 m with 650 m being above Screw Lane

The land rises 22 m (90 - 68) to Screw Lane then upwards by 73 m (163 - 90) above Screw Lane

The gradient along the stream flow path is;

1	Vicarage Ball to Screw Lane is 2.7 deg	[tan-122/(1125-651)]
2	Screw Lane to Trig point is 6.4 deg	[tan-1 (73/651)]

The cultivated land is 2.4 times steeper than that below Screw Lane with roughly equal areas of about 60 acres





## 3 Harberton flood plain

Harberton's flood plain is well-documented. A number of drain and culvert mitigation schemes have been engineered in recent years including an under-road junction under the lowest part of Vicarage Ball.



## 4 Flooding history

This flood was congruent with the left hand of the 'Y' of the published flood plain here in orange, designating medium risk. The red area and dots are deemed high risk.

There are many previous incidents, but this appears to be the worst in living memory. It was worse than the Tristford Road flooding in late December 2000 from land behind the Parish Hall.



## 5 What happened?

The Met Office state that the first half of September in England was the hottest on record dating back to 1884. This was caused by the jet stream flowing to the north of the UK.

There were multiple thunderstorms on the night of 16/17th September throughout Devon. The Environment Agency's 'Slipperstone' rain gauge near Harbertonford recorded the maximum rainfall as 17.3 mm over the 15 minute period ending at 01:30 Zulu (GMT), 02:30 British Summer Time.

2023-09-17T00:00:00Z	0.8	Harberton does not have an EA rain gauge as it does not
2023-09-17T00:15:00Z	0.4	nave a river
2023-09-17T00:30:00Z	1.8	
2023-09-17T00:45:00Z	3.5	As a proxy, applying these readings to Harberton, the total for this 2hr 15 min period of 10 readings is 38 mm
2023-09-17T01:00:00Z	4	
2023-09-17T01:15:00Z	4.4	
2023-09-17T01:30:00Z	17.3	The peak is 17.3 mm
2023-09-17T01:45:00Z	5.2	
2023-09-17T02:00:00Z	0.5	
2023-09-17T02:15:00Z	0.1	

The gauge at Harbertonford recorded 14.2 mm 15 minutes earlier, so there is some cross-validation of the two gauges. (see Appendix for the full night's data)



The water heading into Harberton from the north east can be assumed to have fallen on this blue polygon plan area of 268,000 m<sup>2</sup>

Therefore the volume of water in this period was;

**10,000 m<sup>3</sup>** (268,000 X 0.038)

... and the peak 15 minutes was

**4,500 m<sup>3</sup>** (268,000 X 0.017)

Just under half of the 2 hr 15 min period's rainfall fell in 15 minutes.

These numbers are not definitive, but are an attempt to indicate the scale of the event.

We will never know how much was

absorbed by the soil.

This is what 1m<sup>3</sup> (=1000 Litres = 1000kg =1 tonne of water) looks like.

If the rain gauges were accurate, and Harbertonford's rain gauges are a good proxy for Harberton, then the maths above suggests we had 10,000 of these containers in 2.25 hours and 4,500 in 15 minutes.



The fire service arrived at approx 04:30 to relieve flooded houses, opening up blocked culverts, breaking down doorways, and pumping out certain properties.

## 5.1 Flood water contents

The flood stream consisted of water-borne mud and chopped straw.

The fields north of Screw Lane had been minimally tilled in line with current farming practice. This resulted in short lengths of straw on a shallow bed of tilled dry soil, with a compacted soil subbase.



## 5.2 Water pathway

5.2.1 The water ran down the fields north of Screw Lane. Fields 1,2,3 and 4 were freshly tilled, the others to the north had a well-established crop.



The water, mud and straw gathered against the southern borders of those fields forming the north border of Screw Lane.

The white lines show the flow paths as seen in the photographs. Detailed photos are available.

The water exited onto Screw Lane at various points, but particularly through the two gateways at east and west parts of the lane.









P Cogley, Harberton Flood ver 2023 Oct 21

Water banked up and pooled along the fields' southern banking forming the north side of Screw Lane.







Established crop north of fields 1,2,3 and 4, looking down on the freshly-tilled and seeded fields in the far distance.



5.2.2 The flow went through the two field gateways and hedge apertures onto Screw Lane. The run-off was held between the high banks on either side as the buddle holes blocked with straw and mud. The evidence on this gate indicated there was minimal build-up behind the gate. Its open structure allowed relatively free flow to scour the gateways clear with minimal straw retention up to three bars high on the gate.





5.2.3 Screw Lane has a slight hump to the east of Field 1's gate. This caused the flow from this filed to head west which spilled round and pooled in Threshing Barn's driveway.





Threshing Barn's driveway walls held. As Screw Lane filled up, the hump was submerged, and the gateway and buddle holes on the south side of Screw Lane overflowed. Screw Lane became a huge attenuation pool.



A tractor the following morning in the lower part of Screw Lane, heading east.

Note the left hand stream still running towards the tractor.

Screw Lane's hump is still submerged, 10 m behind the tractor.

Here is the hump some time later ...



5.2.4 Two separate flow streams headed south down over the meadow.



Main flow from upper field, across Screw Lane



Looking north at 2 streams heading south forming a 'Y' shape



One stream heading south



Stream with fields in upper background

This grassland had only recently been cleared of brambles and other vegetation

5.2.5 The two streams ran south down across the grassland bowl into an existing pond.

This pond was dug many years ago to act as an attenuation pool for flood water. There were plans to deepen it as it had silted up over recent years. Many years ago hurdles were placed above this pond to capture silt from above. Being shallow, the pond overflowed, but it's banks remained intact and were not scoured.



Looking north towards field 1 in the upper part of this shot, with the pond in the foreground

5.2.6 The pond overflowed into this subordinate pool,



... then onwards south east down to the village. It is joined by a much smaller stream from the cricket pitch road. There are freshly broken fences, but no evidence of any significant dams along the stream.



The stream has 1.5m levees on it's west bank to protect the field to the south. However there are gaps in the levee which caused spillage



Levee gap and spillage



The levee spillage eastwards was significant. It backed up against the Gunnera plants behind Ashbrook Cottage



5.2.7 The stream pushed through to the side of Ashbrook Cottage where it pushed over a north wall. It spilled north to Town Farm and east along the road behind St Clement's Terrace.





Collapsed wall at Ashbrook Cottage

South east flow through Ashbrook Cottage side gateway.

The front garden's picket fence was carried across the carpark to St Clement's terrace.

## 5.2.8 Three culverts

All the surplus water north east of Harberton comes into culverts in a series of 3.

The first culvert heads west under Ashbrook Cottage's garage. This culvert was overwhelmed. The flow went around both sides of the garage, taking the side gate off it's hinges.

The flow through the Ashbrook culvert then went west for a few metres to Town Farm Barn. It dog-legs at Town Farm Barn's rear culvert. Town Farm Barn flooded from front and rear as the flow went approx 220 degrees around the house.



The culverts are round tubes. The flow through a pipe is proportional to it's cross-sectional area (CSA). The CSA varies with the square of diameter [  $CSA = Pi (D/2)^2$  ]

Ashbrook and St Clement's CSAs are 0.43 m<sup>2</sup>, St Clement's is half the size at 0.27 m<sup>2</sup>.

Only St Clement's has an inclined debris grating, which became clogged.

More on culvert debris gratings here:

https://bpb-us-w2.wpmucdn.com/sites.udel.edu/dist/0/7241/files/2018/03/CACR-05-03-Kobayashi\_Kagawa-v6ydhs.pdf

The three culverts are in a series. Ashbrook first, then Town Farm Barn and finally St Clement's.

It is not good practice to have the last in the series half the size of the two upstream. They were installed at different times.

A crucial question is what percentage of the 10,000 m<sup>3</sup> of water in 2.25 hours came into these culverts? What is the maximum flow rate of clear water that these culverts could absorb? What flow rate were they designed for?

In particular, can St Clement's 0.27 m<sup>2</sup> culvert pass 4,500 m<sup>3</sup> in 15 minutes?

The answers to these questions is vital and should be available from civil engineering empirical evidence and hydrodynamic tables.



The Fire Service cleared the culverts at 04:30. Unfortunately the degree of blocking was not recorded or witnessed in any detail at time of writing.

5.2.9 The main stream then ran downhill to the south. It blocked the culvert at the western end of St Clement's Terrace. Fortunately, the north wall behind St Clement's was not breached.

Note the water mark in the culvert is 250mm (10 inches) below the topping stones.



Inclined grating over the culvert

St Clement's rear wall

The flow spread out to all low-lying properties to the south, including 6 Wesley Place where it entered the rear, traversed the house, and exited the front door at letterbox level. It also went east to Tristford Road where colliding floating wheelie bins woke the first responder.





The flow flooded the front gardens of St Clement's





A video of this is flow available



The high water mark on the doorframe brickwork is 4 bricks above the level on this photo taken at 03:09 which is 39 minutes after the peak rainfall measured on the rain gauges, so good correlation. 5.2.10 The flow passed around both sides of St Clement's Terrace, taking wheelie bins down Tristford Road. It carried on south, heading down Fore Street, crossing the road to flood St Andrew's cottages from the western gateway where the sandbags are in this photo.



5.2.11 It flowed down Fore Street to Vicarage Ball, pooling on the southern kerbside of Vicarage Ball.

The lowest properties along the southern edge of Vicarage Ball suffered with the flow passing through, around and past them. The road camber protected northern driveways e.g. Globe House. Wesley House and no 4 & 5 St Andrew's cottages escaped lightly.

Fortunately this resident's drive was designed as a spillway when the old cow track was lowered to build the two houses.

He was woken and opened these gates, increasing the rate of spill to the stream at the rear.

This thinking needs to be applied to all the checkpoints of this flood. Spillways do not have to be grand concrete chutes, just graded slopes that are kept clear.

His house was spared, those either side were not.



5.2.12 Preston barns 'U' shaped courtyard had the lowest affected properties and now perhaps the more challenging mitigation for future floods as the original archway has been in-filled.



Note the flow did not reach the second stream entering the village from the east. This is a completely different system from a different valley. The stream was full, but contained within its banks. The mud on the road here came from the west, not the stream from the east.

The flow was sufficient to lift and move cars.



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5.2.13 The final chokepoint was the narrowing of the stream heading down to the sewage works to the south of Vicarage Ball.



The waterline / scouring mark can be seen on the southern bank and gate rails.



There was only a few traces of mud and straw in the garden of the Old Forge. Presumably this was caused by the stream's chokepoint above causing a

backing up against this garage door. The Old Forge did flood as it sits lower than this garage.

It was not all bad news. No 4 St Andrew's cottages had a well-fitting, sealed front door. It withstood the main flow with minimal ingress.



## 6 The Farmer's point of view

The farmers write;

'We re-seeded the fields into grass. We decided to not plough the fields as this can lead to soil erosion problems. So instead we min-tilled the fields only disturbing the top inch or so of top soil.

Obviously as we all know we had 3/4 inches of rain in a couple of hours and the fields understandably couldn't cope with the shear quantity of water leading to the run off.

Since the event we have met with the environment agency who confirmed it was an unfortunate set of circumstances that we couldn't do anything about. The only thing they did say was that due to the fields not being ploughed there was a certain amount of compaction which obviously effects the amount of water the ground can soak up. However, it is my firm believe with over 40 years of farming experience that if we had ploughed the fields the washing would've been considerably worse.

We have now at the request of the environment agency sub soiled the fields and that is how they will remain till the spring.

Going forward unfortunately there is little we can do to stop wash if we have such extreme weather events shortly after fields have been cultivated. One step we can and will take is to move the gateway on screw lane into the opposite corner as where it is situated is the natural run for water and if it had been blocked up at the time would've helped to hold back at least some of the soil.

Many thanks, Robert and Jamie Rogers.'





An example of a sub-soiler being used in one of the fields above Screw Lane several days after the event. The work is along the contour lines of Field 3.

The deep blades break and lift compacted sub-soil

## 7 Observations

There is as much land area above Screw Lane than there is below it. The topography is that of an ever-steepening catchment bowl, partially exposed to the prevailing moist south westerly airstream forcing it upwards to 163m, stimulating precipitation. The EA describe it as a good 'flash-flood catchment'.

The rain gauges readings give the rainfall profile that night. It peaked shortly before 02:30 and had stopped flowing by dawn, leaving wet mud and straw. There were several areas where the flow was captured and perhaps temporarily halted. This appears to have caused backwash and raised the water level at each of these locations. When each of these were breached, the flow was released downstream to the next. Presumably, Flow > Blockage > Backwash > Rising water > Release. However It could simply have been one very short, fast deluge with several slight interruptions. Everyone was in bed, no-one saw the worst part of it.

Wesley House, the former chapel, with walls all around was in the flow path, but minimally affected. This shows the benefit of walled surroundings laid with mortar. No 4 St Andrew's cottages showed the benefit of a well-sealed front door. One loose-laid garden wall was pushed over. The more substantial walls around St Clement's Terrace held. Given the height of the water at St Clement's, had one of the higher walls failed there could have been injury. The relative culvert locations, sizing and grating needs to be reviewed. Note these are likely to be the property (riparian) owners' responsibility.

The key question is: Did the mud and straw actually attenuate a far worse clear water torrent?

Thankfully, Screw Lane was a temporary attenuation pond. It's high banks with straw and mud blocked the gaps, reducing the flow rate for a while and restraining a large mass of water.

One can hypothesise that the straw and mud helped prevent a far worse 'clear water' flood. Fastflowing clear water would have had more kinetic energy than the slow-moving gloop we suffered. The mud was terrible to clear up, but would a higher speed flow of clean water have been worse?

The wall was pushed over by kinetic energy. This energy increases with the square of velocity (KE = 1/2 MV<sup>2</sup>)

I m<sup>3</sup> (1000 kg) of water flowing at 2 ms<sup>-1</sup> has a kinetic energy of 2 kJ, increase this flow to 4 ms<sup>-1</sup> and it has 8 kJ. So double the speed and you get 4 times the energy. Increase it to 5 ms<sup>-1</sup> and its 12.5 kJ, over 6 times the energy. It is an exponential increase.

The mud and straw increased the mass slightly, but also the viscosity. The straw caught in the gates, fences, railings and vehicle underbellies. The mud packed into the straw. This reduced the kinetic energy in places to zero as the water slowed and pooled.

## 8 Conclusions

The south of Harberton is aware of the risk of flooding. The Victorians built the first culvert in St Clement's. Various mitigations were in place, but insufficient for the scale and circumstances of this event.

Screw Lane flooding is well understood and a regular item on the Parish Council's agenda, together with the vacancy for a linesman to tend to the various water courses, drains, culverts and buddle holes.

There were seven precursors;

- 1 An record-breaking hot and dry first two weeks of September
- 2 The field minimally-tilled the week before, loosening the dry topsoil
- 3 Straw chopped into short lengths (but note long straw was baled and removed)
- 4 The grass seed that had been sown did not have time to establish itself
- 5 Extraordinarily high rainfall over 2 hours with an exceptional 15 minute period
- 6 Lack of culvert debris management and, perhaps, St Clement's culvert sizing
- 7 Inadequate flood mitigation on specific properties in a known flood path and flood plain

Attention to farming / land management, tidying-up waterways and some basic hard and soft engineering will reduce greatly the effects of the next flood.

## 9 Recommendations

The farmer's intention to revert to grassland may stop an event like this, but it will not solve the fundamentals. "It may have been his soil and straw, but it was not his water"

Farms get sold on, methods change, cash crops come and go, memories fade, so nothing is guaranteed.

There are predictions of more extreme weather events. The farmers write that little can be done to prevent wash after soil cultivation on steep hillsides. Therefore, the precautionary principle should prevail. Something similar happened 23 years ago. The lessons appear not to have been applied.

It is vital that an holistic approach is taken. Easing the flow upstream will cause increased flow for those downstream. Take the mud and straw away, open the channels upstream and all is well. However you then get high velocity water. This just increases risk for Vicarage Ball's southern properties.

It is likely that some combination of capture and flow management should be used. Different solutions are needed above Screw Lane to those needed below it.

The solutions are outside the scope of this report, but may include swales, detention basins and attenuation ponds. Maybe Screw Lane should be considered a causeway? After all they close the seafront roadway in Torquay regularly in advance of storms.

contd ...

## 9.1 Must dos:

9.1.1 All properties subject to the main stream should have flood gates or at least flood-tolerant doors with multi-point cam closers. Perhaps outward-opening with no cat flaps and low letter-boxes. Particularly St Clement's Terrace, St Andrew's Cottages and all properties along the south side of Vicarage Ball. Flood-proof air-bricks are also needed for suspended wooden floors.

9.1.2 Ashbrook Cottage, The Old Forge, Preston Barns and the St Clement's Terrace front gardens should have spillways to take the flow to the stream.

9.1.3 Preston Barns need specialised attention, with a flow path to the stream to the rear

9.1.4 Flooding in Screw Lane is a long standing issue that should receive extra attention, That said, note the attenuation effect it played in this flood.

9.1.5 All streams should be cleared regularly. Presumably by linesman, but also residents.

9.1.6 Culvert CSAs and use of debris gratings needs to be validated.

9.1.7 Home owners need to declare their possible riparian status to their insurers, who will probably know already.

9.1.8 This report to be scrutinised by the appropriate subject matter experts under the direction of the appropriate agencies to produce the expert's view.

## 9.2 Advisories:

9.2.1 All stream-facing walls should be inspected for integrity and made flood-load bearing. Flood walls and gates must not be too high. Over-topping must be possible to reduce static and dynamic water pressure.

9.2.2 Rising water needs to be sensed and alerts given. Harberton needs rain gauges giving real-time alerts. If we know early at the source we have a chance. Secondary flow monitoring systems should be installed at chokepoints, particularly culvert entrances to sense the rate-of-change of flows. Perhaps a vee-notch wier could be constructed in St Clement's

9.2.3 The long-standing linesman vacancy should be pursued with vigour. The responsibilities should include first-line alarm system maintenance.

9.2.4 Resident's should consider 'Adopting a drain'. This existed some years ago. A couple of folk regularly clear the grating on the stream from the east and residents tend to their own culverts. This should be made more formal with appropriate back-up for absences.

9.2.5 The farmer's suggestion to block up his gateway(s) needs to be factored into the plans for Screw Lane's drainage.

Peter Cogley October 21st 2023

## APPENDIX

Recordings for the two Environment Agency rain gauges in Harbertonford.

There is no EA rain gauge in Harberton, so these were used as proxies.

The 'Z' means Zulu Time, which is the same as GMT. Add I hour to get BST.

The storm (UITC)	Rainfall (mm)	Timestamp (UTC)	Naimai (internet)
Timestamp (UTC)	0	2023-09-16T15:00:00Z	0
2023-09-16115:00:002	0	2023-09-16T15:15:00Z	0
2023-09-16115:15:002	0	2023-09-16T15:30:00Z	0
2023-09-16115:30:002	0	2023-09-16T15:45:00Z	0
2023-09-16115:45:002	0	2023-09-16T16:00:00Z	0
2023-09-16116:00:002	0.2	2023-09-16T16:15:00Z	0.1
2023-09-16116:15:002	0	2023-09-16T16:30:00Z	0
2023-09-16116:30:002	0.2	2023-09-16T16:45:00Z	0.1
2023-09-16116:45:002	0	2023-09-16T17:00:00Z	0
2023-09-16T17:00:002	0	2023-09-16T17:15:00Z	0.1
2023-09-16T17:15:00Z	0	2023-09-16T17:30:00Z	0
2023-09-16T17:30:00Z	0	2023-09-16T17:45:00Z	0.1
2023-09-16T17:45:00Z	0.2	2023-09-16T18:00:00Z	0
2023-09-16T18:00:00Z	0.2	2023-09-16T18:15:007	0
2023-09-16T18:15:00Z	0	2023-09-16T18:30:007	0.1
2023-09-16T18:30:00Z	0	2023-09-16718:45:007	0
2023-09-16T18:45:00Z	0	2023-09-16118:45:002	0.2
2023-09-16T19:00:00Z	0.4	2023-09-16119:00:002	0.5
2023-09-16T19:15:00Z	0.6	2023-09-16119:15:002	0.2
2023-09-16T19:30:00Z	0.2	2023-09-16119:30:002	0.1
2023-09-16T19:45:00Z	0	2023-09-16119:45:002	0.1
2023-09-16T20:00:00Z	0	2023-09-16120:00:002	0
2023-09-16T20:15:00Z	0	2023-09-16720:15:002	0
2023-09-16T20:30:00Z	0.	2023-09-16T20:30:00Z	0
2023-09-16T20:45:00Z	0	2023-09-16T20:45:00Z	0
2023-09-16T21:00:00Z	0	2023-09-16721:00:002	0
2023-09-16T21:15:00Z	0	2023-09-16T21:15:00Z	0.1
2023-09-16T21:30:00Z	0.2	2023-09-16T21:30:00Z	0.2
2023-09-16T21:45:00Z	0.4	2023-09-16T21:45:00Z	0.2
2023-09-16T22:00:00Z	0.2	2023-09-16T22:00:00Z	0.5
2023-09-16T22:15:00Z	0	2023-09-16T22:15:00Z	C
2023-09-16T22:30:00Z	0.2	2023-09-16T22:30:00Z	(
2023-09-16T22:45:00Z	0	2023-09-16T22:45:00Z	0.1
2023-09-16T23:00:00Z	0.2	2023-09-16T23:00:00Z	0.1
2023-09-16T23:15:00Z	0.6	2023-09-16T23:15:00Z	0.:
2023-09-16T23:30:00Z	1.4	2023-09-16T23:30:00Z	1.1
2023-09-16T23:45:00Z	1.2	2023-09-16T23:45:00Z	1.
2023-09-17T00:00:00Z	1.2	2023-09-17T00:00:00Z	0.
2023-09-17T00:15:00Z	0.6	2023-09-17T00:15:00Z	0.
2023-09-17T00:30:007	8.2	2023-09-17T00:30:00Z	1
2023-09-17T00:45:007	7.6	2023-09-17T00:45:007	7
2023-09-17T01:00:007	11.2	2023-09-17T01:00:007	<u>J.</u>
2023-09-17T01:15:007	14.2	2023-09-17T01:15:007	1
2023-09-17T01:30:007	4.6	2023-09-17T01:30:007	4.
2023-09-17T01-45-007	4.0	2023-09-17101:45:007	17.
2023-09-17T02-00-007	10	2023-09-17101.45.002	5.
2023-09-17102.00.002	2.2	2022-09-17102:00:002	0.
2025-09-17102:15:002	0.2	2023-09-17102:15:002	0.
2023-09-17102:30:002	0.2	2023-09-17T02:30:00Z	
2023-09-1/102:45:002	0	2023-09-17T02:45:00Z	0