Luston Group Parish Council

Flood Alleviation Recommendations, Luston, Herefordshire

Report LL0058
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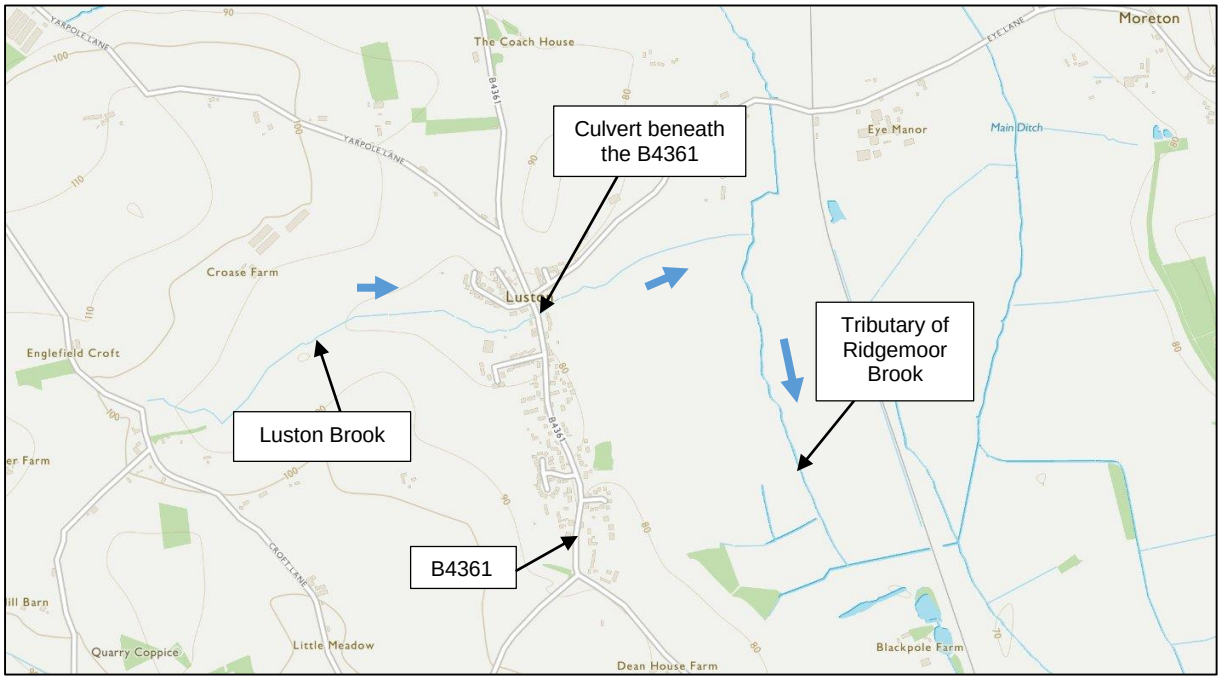
1 Introduction

The aim of the study is to improve understanding of the flood risk from all sources affecting Luston and to provide information to enable the Parish Council to work with the community and local authorities to reduce the impacts of flooding. In particular, the Parish Council is keen to understand what actions and measures can be undertaken locally to reduce flood risk.

1.1 Location

Luston is located in the north of Herefordshire with the B4361 from Leominster to Ludlow, passing through the middle of the village. Luston Brook flows as an open channel from west to east through the village and is culverted for approximately 12 m beneath the B4361. The brook continues to flow east until its confluence with a watercourse flowing south to the Ridgemoor Brook, a tributary of the River Lugg (Figure 1).

Figure 1 Ordnance survey mapping of Luston, showing main watercourses



Source: https://osmaps.ordnancesurvey.co.uk/52.26546,-2.74448,15

1.2 Site Visits

A site walkover along the main areas of flood risk in the village was undertaken by Chris Nugent, Lidar-Logic, accompanied by Ian Stevens and Chris Pearson in August 2020. During this visit, several features of relevance to flooding and flood flow paths were identified. The walkover highlighted that there are two main sources of flood risk to the village, Luston Brook around the culvert beneath the B4361 and surface water flooding associated with agricultural land along the village's western margin.

A further site visit to Luston Primary School was undertaken by Chris Nugent, in January 2021. Inspection of the school grounds and the routes of water ingress during flooding were discussed with the school headteacher and one of the school Governors.

1.3 Flood Risk Assessments in Herefordshire

Flood Risk within Herefordshire has been investigated in a number of high-level studies, the most recent of these sources are listed below:

1. Preliminary Flood Risk Assessment (PFRA), May 2011 and Addendum, Dec. 2017;
2. Local Flood Risk Management Strategy Updated, April 2017;
3. Herefordshire Strategic Flood Risk Assessment (SFRA), April 2019;
4. Herefordshire Flood Alleviation Strategy, Amey, 2010

A brief summary of these sources of information and any specific reference to the village of Luston are provided in the following Sections.

1.3.1 Herefordshire Preliminary Flood Risk Assessment – May 2011

Herefordshire Council was required to prepare a Preliminary Flood Risk Assessment (PFRA), which is an assessment of floods that have taken place in the past and could take place in the future. The PFRA report provides a high-level overview of flood risk from local flood sources including surface water runoff, groundwater and ordinary watercourses.

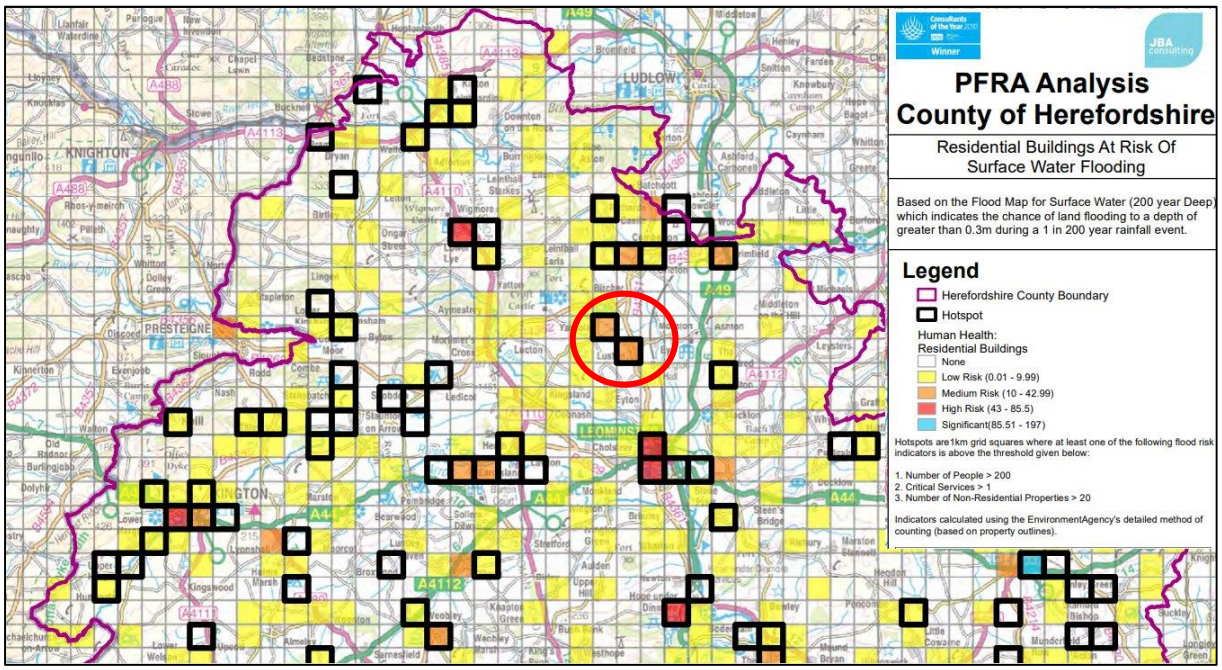
The Herefordshire PFRA[1] was prepared in 2011, with an addendum to the report published in December 2017. The PFRA created a series of maps to assess the surface water flood risk within the county, based on two national datasets provided by the Environment Agency. The thresholds between the categories were determined based on the number of properties affected by flood risk, to categorise the risk into Low, Medium, High and Significant. The actual threshold values are shown in the Key of Figure 2, which is adapted from Figure 5.2 within the PFRA report. It identifies locations within Herefordshire where residential buildings where previously affected by surface water flooding. Luston is shown as a hotspot (circled in red), with a medium risk, that is defined as "*between 10 and 42 residential properties at risk of surface water flooding*".

In order to assess flood risk from ordinary watercourses the PFRA collated the information held by Herefordshire Council on past flood events. A countywide flood history spreadsheet was constructed based on this information, identifying the sources and mechanisms of flooding. In the preparation of this spreadsheet, it was found that some records had limitations and were often incomplete, these records were excluded from the spreadsheet. The recorded flood event of July 2007 was noted to have affected towns and villages within Herefordshire, however there is no specific reference to Luston.

An addendum to the PFRA2 was published in 2017, following a review of the flood risk data and information available at this date. It was concluded that there was no change to the assessment of flood risk at Luston, since the PFRA report was first produced, in 2011.

[1] Preliminary Flood Risk Assessment (JBA Consulting, May 2011)
https://www.herefordshire.gov.uk/downloads/file/2906/herefordshire_preliminary_flood_risk_assessment
[2] Herefordshire Preliminary Flood Risk Assessment Addendum (Herefordshire County Council, Dec, 2017)
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/698523/PFRA_Herefordshire_County_Council_2017.pdf

Figure 2 PFRA analysis of surface water flood risk hotspots (adapted from Figure 5.2[1])



1.3.2 Local Flood Risk Management Strategy (2017)

Herefordshire Council, as Lead Local Flood Authority (LLFA) for the county, is required to develop, maintain, apply and monitor a local flood risk management strategy as part of its responsibilities of the Flood and Water Management Act 2010. The Local Flood Risk Management Plan for Herefordshire was published in October 2017[3]. The Strategy is accompanied by an Action Plan that sets out how the council plans to deliver the strategy over the next 6 years, before it is reviewed and updated in 2022. Herefordshire Council's aim with respect to the management of local flood risk with the county is stated:

> "*to continually improve the way in which flood risks are managed throughout the county to reduce the impacts of flooding on lives and livelihoods". (p.4)*

The report considers the management of flood risk from various sources, with greater focus on the 'local' sources for which the LLFA are responsible: surface water, groundwater and ordinary watercourses. No specific reference is made to Luston within the report or to any of the historic flood risk sources that have impacted on the residences and school.

In Section 7 of the strategy, the responsibility of Herefordshire Council to implement a clear and transparent system for the prioritisation of areas is discussed. Areas considered to be at greatest risk of flooding or that may experience the greatest consequences should a flood event occur should be prioritised. It is not possible to eliminate flooding within Herefordshire; however, the council states its commitment to managing the flood risk as far as practicable whilst taking into consideration factors such as the source of flood risk, frequency, hazard, the vulnerability of the affected communities and infrastructure, available funding and community support.

[3]Herefordshire Local Flood Risk Management Strategy, Herefordshire Council, October 2017
https://www.herefordshire.gov.uk/downloads/download/1809/local_flood_risk_management_strategy

The report highlights that Herefordshire Council are keen to promote individual and community responsibility for managing local flood risks, thereby promoting ownership of the actions that are taken and the measures that may be implemented. Objective 3 of the Council's Objectives for local flood management is titled 'Help the Community to Help Themselves', it is stated in Section 8:

> "The council encourages local communities to propose and implement local initiatives for managing local flood risk, and where appropriate we will support these initiatives in the council's role as Lead Local Flood Authority" (pg.45).

Herefordshire Council recognises the importance of community involvement, with local communities often best placed to understand the causes and effects of flooding within their local area. Section 7.5 outlines Herefordshire Council's prioritisations for investment of flooding and resources in the mitigation of flood risk. Community support is considered an additional influencing factor and the strategy states states:

> "The council may also be able to give preference to those communities which are actively supporting a flood management scheme" (pg.44).

In Section 8.5, the creation of a Community Resilience Working Group is encouraged, in which local communities investigate and present opportunities for managing flood risks within their area. The council looks to assist with funding of these schemes, if they are consistent with the Council's prioritisation hierarchy or if the schemes offer multiple benefits or partnership funding opportunities (i.e. if the scheme can offer other benefits such as improved biodiversity, or if the scheme can be part funded by another organisation or the community itself, or both).

The council encourages local communities to research and apply for other sources of funding that may be available for flood risk management initiatives (e.g. government and National Lottery funded, regeneration grants). The funding available for any flood risk management measure will be linked to the outcomes it will provide, measures that deliver benefits beyond flood risk management, such as enhanced ecosystems, public amenity, economic growth or cultural heritage, are likely to attract funding from alternative sources beyond those typically used to support flood risk management. It directs readers looking for further information regarding available funding to www.herefordshire.gov.uk or www.gov.uk websites, with alternative funding streams which may be available to support community-led initiative, readers are directed to visit the Hereford funding update website[4].

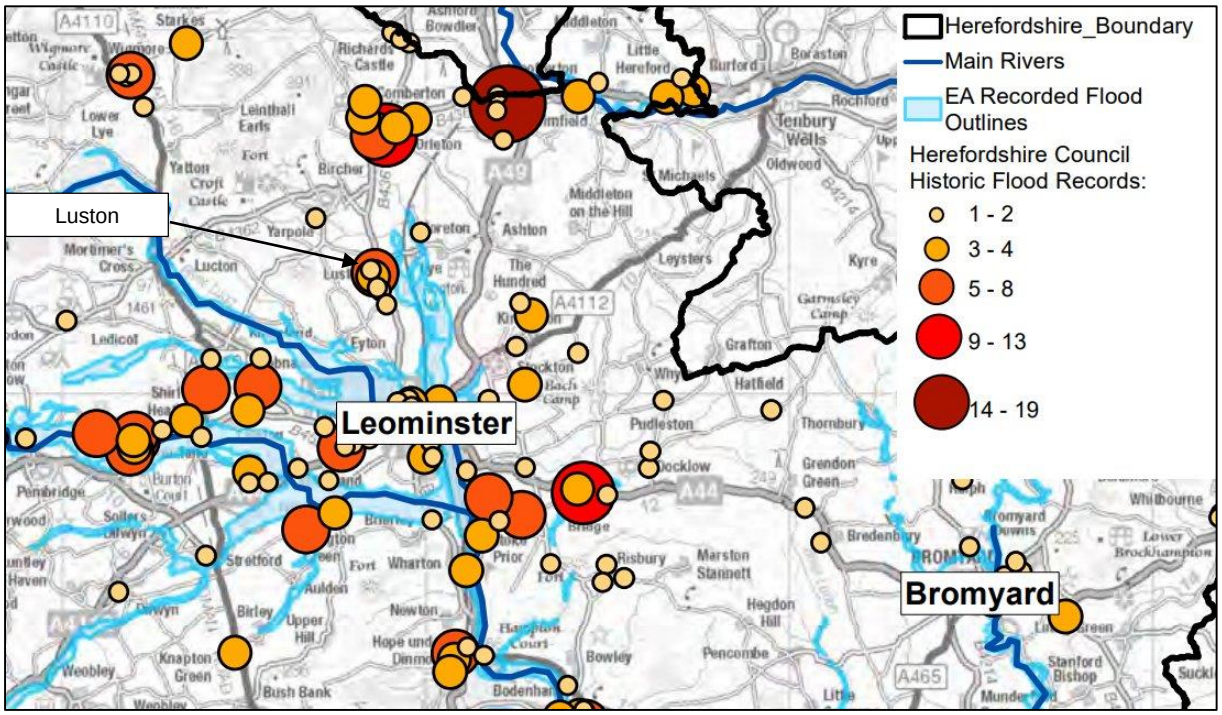
1.3.3 Herefordshire Strategic Flood Risk Assessment (2019)

A Strategic Flood Risk Assessment (SFRA) is a statutory document required under the National Planning Policy Framework (NPPF) to be carried out by Herefordshire Council, as the local planning authority to assess the risk from flooding from all sources, now and in the future within Herefordshire. The Herefordshire Level 1 SFRA[5] was completed in April 2019 and notes the significant flooding that was recorded in Luston during the flood event in July 2007. Flooding is recorded as "significant" when more than five properties are affected. Luston Brook is listed, among others, as an ordinary watercourse which poses "*greatest flood risk*" to properties in Herefordshire.

[4] https://herefordfundingupdate.wordpress.com/
[5] Level 1 Strategic Flood Risk Assessment (Herefordshire Council, April 2019) https://www.herefordshire.gov.uk/downloads/download/1997/strategic_flood_risk_assessment_2019

The number of historical flood events and flood outlines recorded by Herefordshire Council and Environment Agency are shown in Figure 3. Herefordshire Council flood reports are mapped to an anonymous point, on or near the street where the event occurred. The image shows a series of circles over Luston, indicating that there have been five recorded flood locations within Luston. The largest of these circles indicates a record of 9 and 13 reports in one location of the village; however, no further details of these flood events or locations are available within the SFRA.

Figure 3 Map of Herefordshire Council and Environment Agency Flood Records (Adapted from Appendix D-4 in SFRA)



1.3.4 Herefordshire Flood Alleviation Strategy, Amey, 2010

In 2010, a flood study report was undertaken by Brian Faulkner to investigate flood alleviation strategies for locations within Herefordshire. The report was undertaken to inform Amey, on behalf of Herefordshire Council, of flood management options at locations within the County and provide data for bidding for flood scheme funding.

The report investigated local flood history, noting that ten properties were flooded in Luston on 20/07/2007. Flooding occurred to a "*significant depth*" at three of these properties and water levels reached the threshold at Luston Primary School. The following areas of Luston were reported as being affecting during this 2007 flood event:

- Gardens and highways in Westland View, The Willows and Lilac Grove from surface water runoff and overwhelming of local drains.
- Residences in The Fold immediately south of Luston Brook and east of the B4361;
- Central area of Luston at the B4361 bridge;
- Two properties in Westland View, from surface water flooding;
- Luston Primary school, from local surface water flooding.

The report states that:

> *"Flooding is unusual in Luston. Residents have reported that Ashfield Cottage adjacent to the brook has never flooded and older residents have no recollection of flooding on this scale*" (p131)

Brain Faulkner undertook site inspections at the culvert under the B4361 identifying that the culvert may be of adequate size to convey relatively large floods, but considered the approach channel to be "*unsatisfactory*". The report considered the channel to be too constrictive for the approaching flood peaks causing floodwaters to overtop the channel banks and outflank the bridge and flooding the B4361 and properties within The Fold.

This flood mechanism was supported in the report by accounts that the channel on the downstream side was not full, whereas, there was substantial flooding on the upstream side sufficient to inundate the highway (p134). The report proposed two feasible flood alleviation measures for Luston, which are referenced within later sections of this report, alongside further recommendations.

1.4 Summary

The first three reports described above provide a strategic overview of flood risk and management in Herefordshire. Identifying flood risk and the ways Herefordshire Council and other authorities will continue to manage flood risk within the county.

In 2010, Brian Faulkner's Luston specific report for Herefordshire Council, stated that flooding is unusual in Luston, reporting that Ashfield Cottage had never flooded, yet 10 properties were affected in July 2007. Older residents in the village had no recollection of flooding on this scale prior to 2007. By 2011, when the PFRA was published, Luston was identified as a Hotspot with a "*Medium Risk*" from flooding.

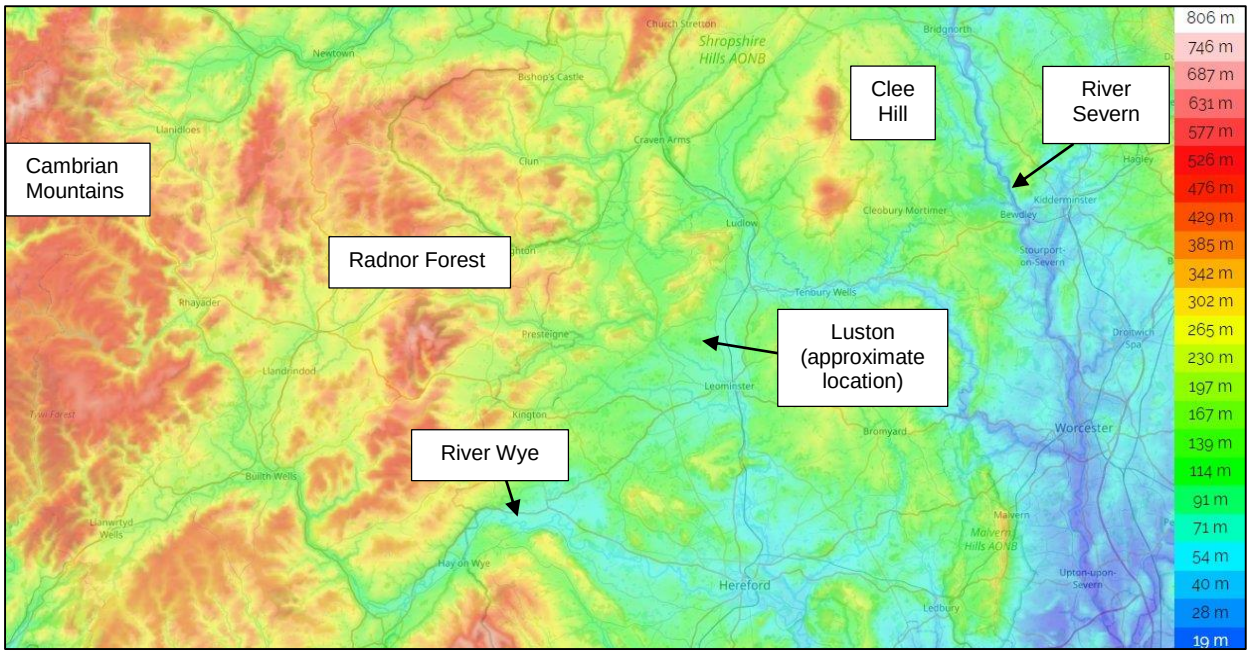
The most recent strategic report for Herefordshire, the SFRA published in 2019, identifies Luston Brook to now be an ordinary watercourse which is posing a "*significant*" flood risk to properties. This increasing flood risk classification between the situation prior to 2007 and the current situation, in which Luston Brook poses a "significant" flood risk to properties, suggests that local or catchment changes have had an impact on the local hydrological regime in Luston.

2 Catchment Conditions

2.1 Topography

The topographic map in Figure 4 shows the regional context around the village of Luston. The brown and red shades indicate the higher land to the west of Luston along the border between England and Wales. The lower land is shown by shades of blue, which bound the courses of main rivers, including the River Wye and Severn.

Figure 4 Regional topographic map surrounding Luston

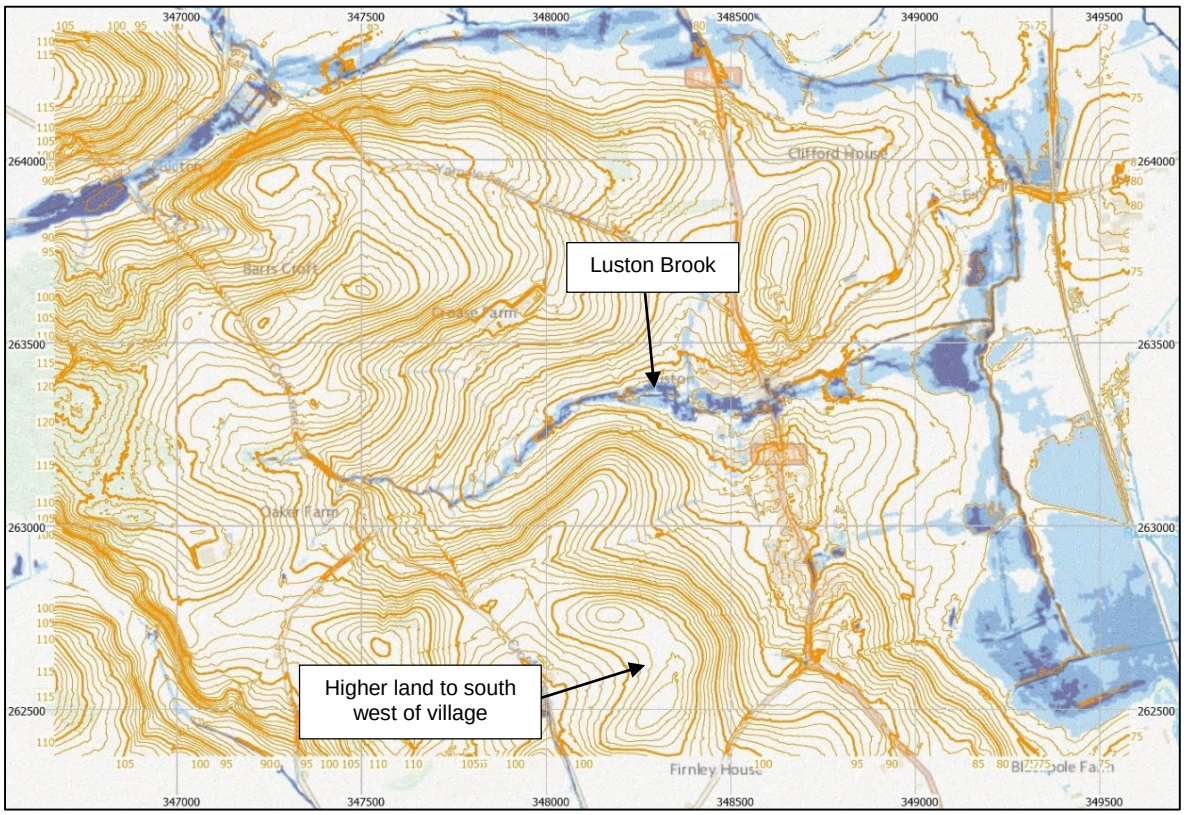


Source: https://en-gb.topographic-map.com/maps/b9/England/

Topographic mapping has been laid over the flood map, in Figure 5 and Figure 6. The contours in Figure 5 have been drawn from LiDAR digital terrain model (DTM) data, which is also used to colour the surface in the layer shaded map in Figure 6. The contour interval in Figure 5 and the layer interval in Figure 6 are the same, at 1 m. Digital surface model (DSM) data has been used in Figure 6 to show locations where surface features such as buildings and vegetation are significantly above the underlying terrain. Any DSM data point that is more than 0.5 m above the corresponding DTM data point is shown with a black dot. In this way, hedgerows, roads and field margins show up as lines of dots.

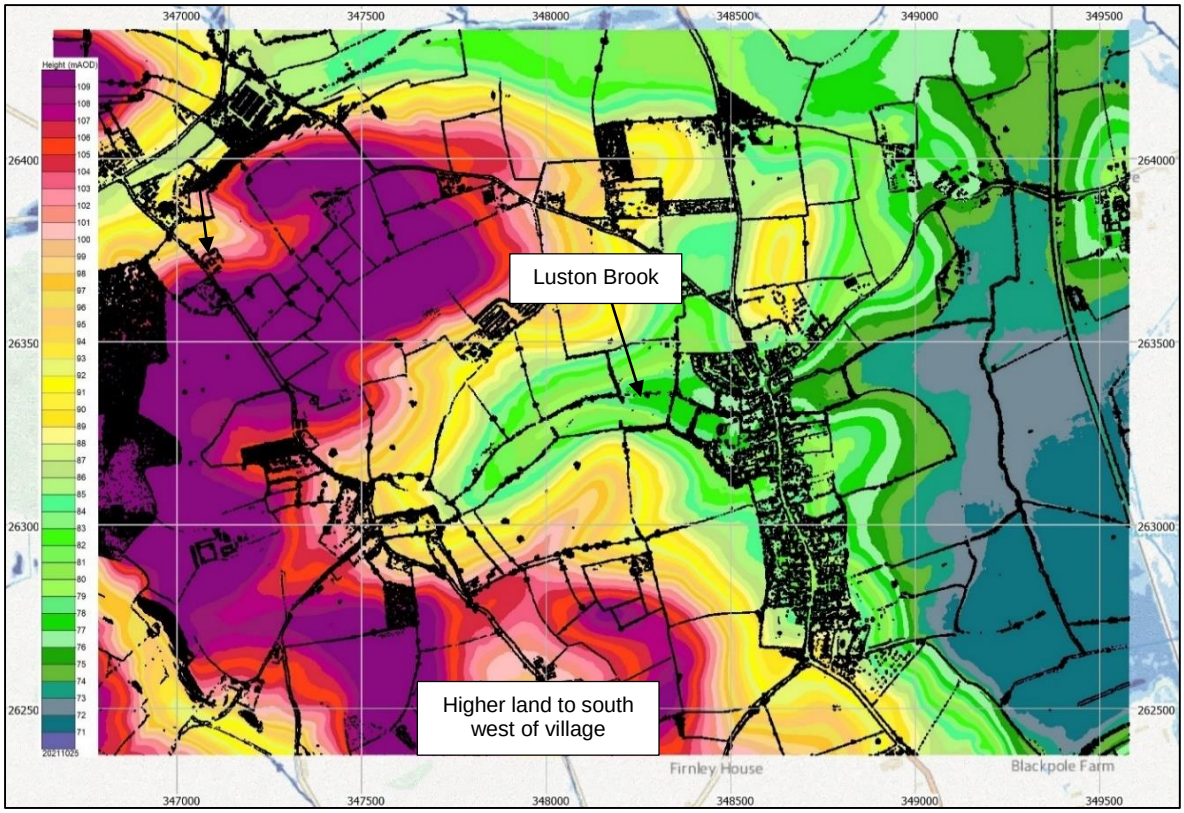
Contours every 5 metres are drawn thick, darker than those between and only the thick ones are annotated in Figure 5. These numbers indicate height in metres above ordnance datum (mAOD), shown around the contoured area. These maps both show higher land to the west of Luston, with ground levels above 109 mAOD. The topography slopes down towards the east with ground levels around 71 mAOD to the east of the village, shown by the blue shades in Figure 6. The topographic mapping in both Figure 5 and Figure 6 identify the line of the valley through which the Luston Brook flows.

Figure 5 Contour map Luston, derived from LiDAR DTM data, contour interval 1 m



Note: Layer interval 1 m

Figure 6 Layer shaded map of the area shown in Figure 5



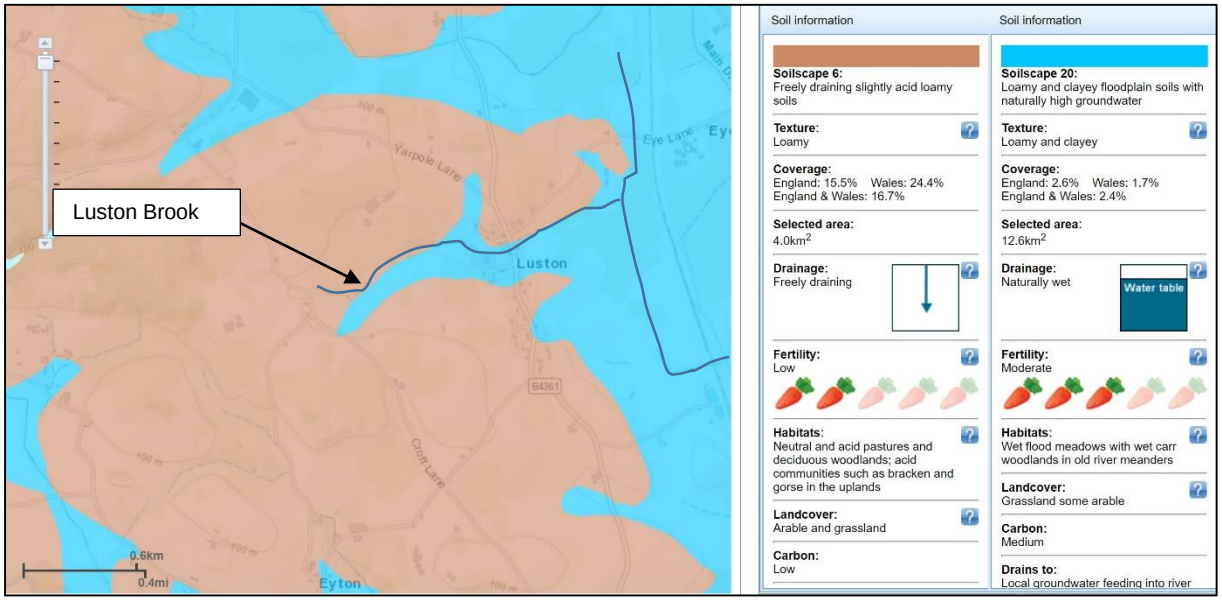
Note: Layer interval 1 m

2.2 Soils & Geology

Regional soil mapping (Figure 7) shows surface soil conditions to be freely draining to the west of the village, with land to the east having loamy and clayey soils with a high water table. Geological mapping (Figure 8) shows the village to underlain by interbedded siltstone and mudstones, of Silurian age. The bedrock is overlain by superficial deposits of alluvium to the east of the village (Figure 9), these deposits are associated with local environments previously dominated by rivers. To the west of the village, the bedrock is overlain by till and morainic deposits, which are glaciogenic in origin, created by the action of ice and meltwater.

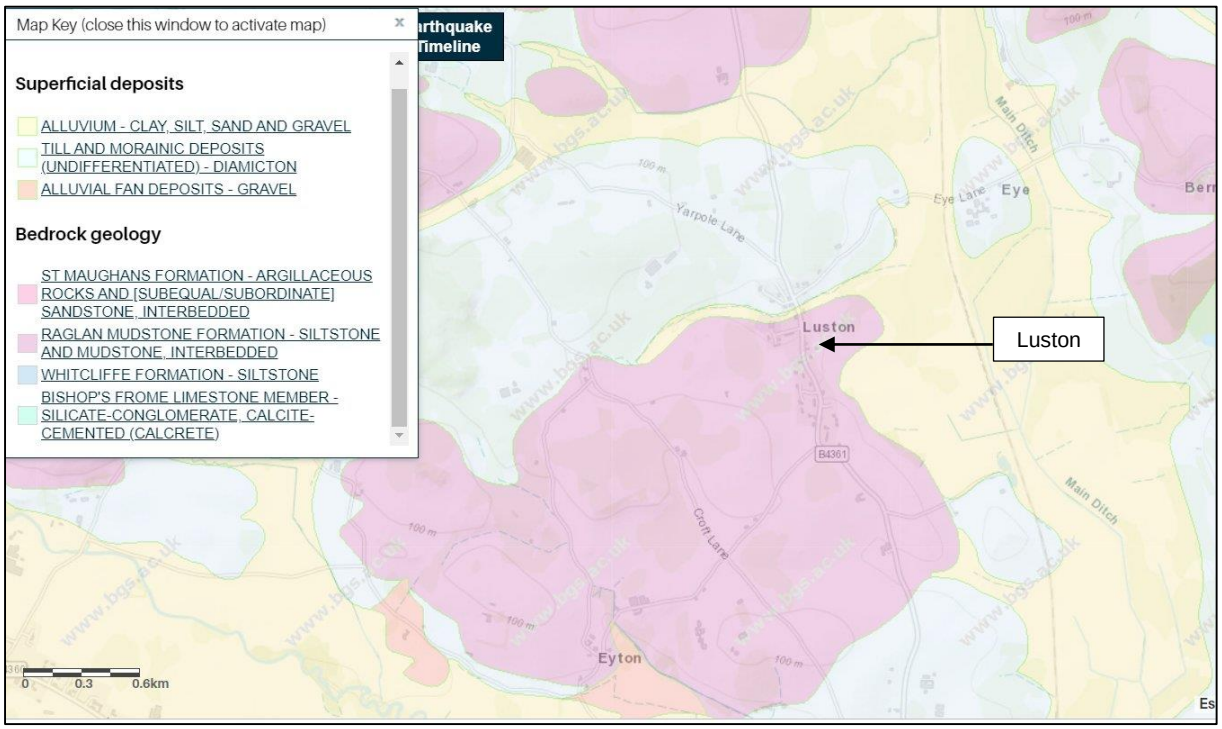
The composition of till and therefore its drainage properties are extremely variable. It is described by British Geological Survey (BGS) in Figure 9 as a "Diamicton". This term refers to a terrigenous sediment that is unsorted or poorly sorted and contains particles ranging in size from clay to boulders, the former term was "boulder clay". Where the sediment is dominated by clay-sized particles, the surface permeability can be very low, leading to high rates of runoff. Although BGS mapping shows that no superficial deposits have been recorded to the south of the Luston Brook and west of the village, it is possible that till also occurs in this area.

Figure 7 Regional soil map covering the village of Luston



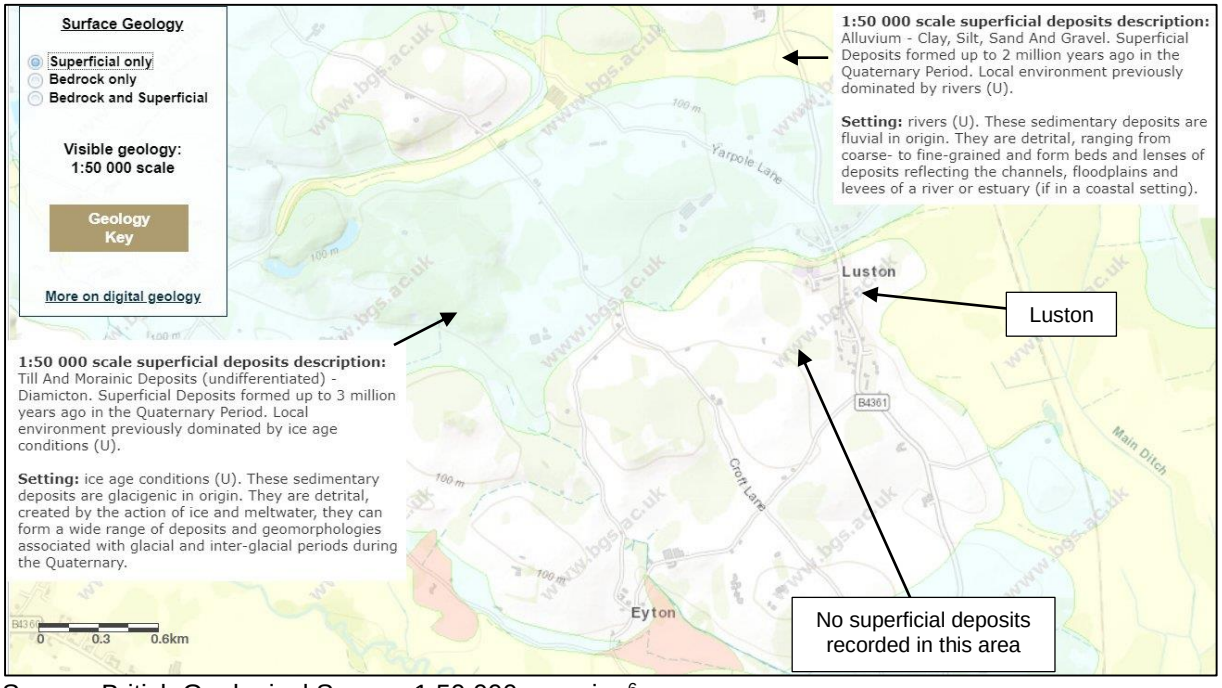
Source: http://www.landis.org.uk/soilscapes/

Figure 8 Local Geology, bedrock geology and superficial deposits



Source: British Geological Survey, 1:50,000 mapping[6]

Figure 9 Geological Map, superficial deposits



Source: British Geological Survey, 1:50,000 mapping[6]

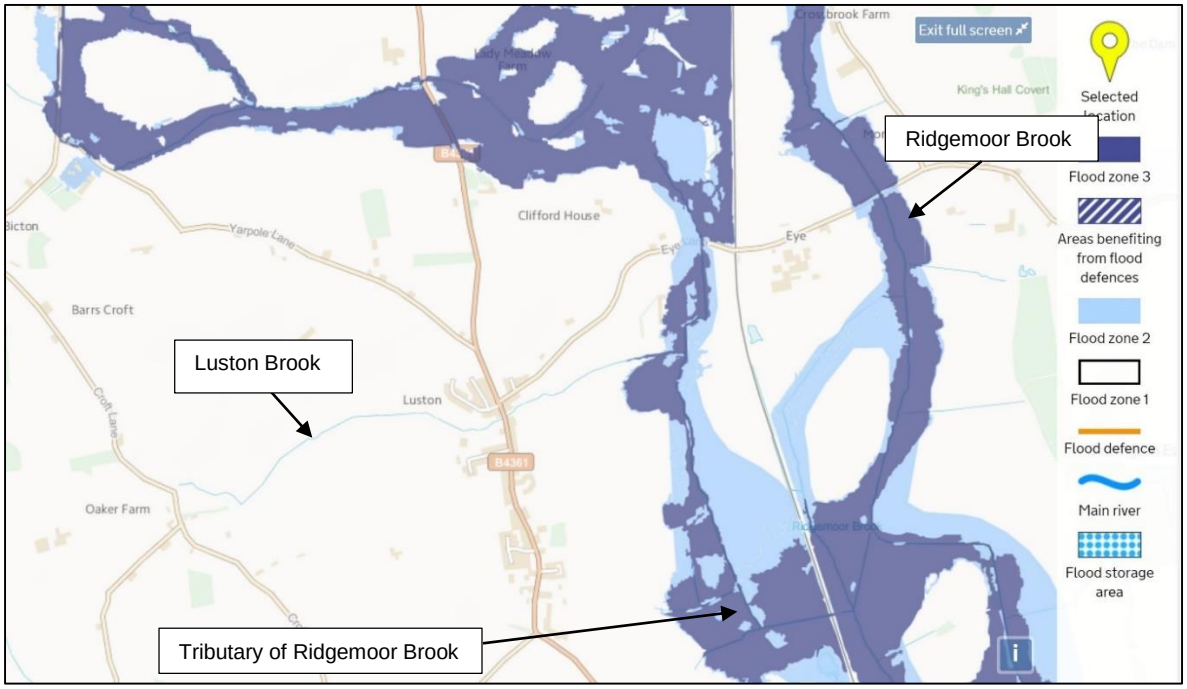
[6] http://mapapps.bgs.ac.uk/geologyofbritain/home.html

3 Flood Risk associated with Luston Brook

3.1 Drainage

Notwithstanding the historical perspective suggested above, there is a recent history of flooding within Luston, with properties and local roads being affected by fluvial and surface water sources. Luston Brook is an ordinary watercourse, defined as a watercourse which is not a main river. The Environment Agency Flood Map for Planning for Luston (Figure 10), indicates no risk of flooding upstream of the village. This may be because flood risk is only assessed on this mapping for catchments above a critical area (*circa* 5 km^2), the FEH catchment of Luston Brook at Luston is given as 1.7 km^2 (
Figure 11). Being below the critical area, this catchment cannot be assumed to be beyond the limits of 1:1,000-year flooding.

Figure 10 Environment Agency Flood Map for Planning



Source: https://flood-map-for-planning.service.gov.uk/confirm-location?easting=348460&northing=263270&placeOrPostcode=Luston

Figure 11 FEH catchment of Luston Brook

Source: https://fehweb.ceh.ac.uk/GB/map

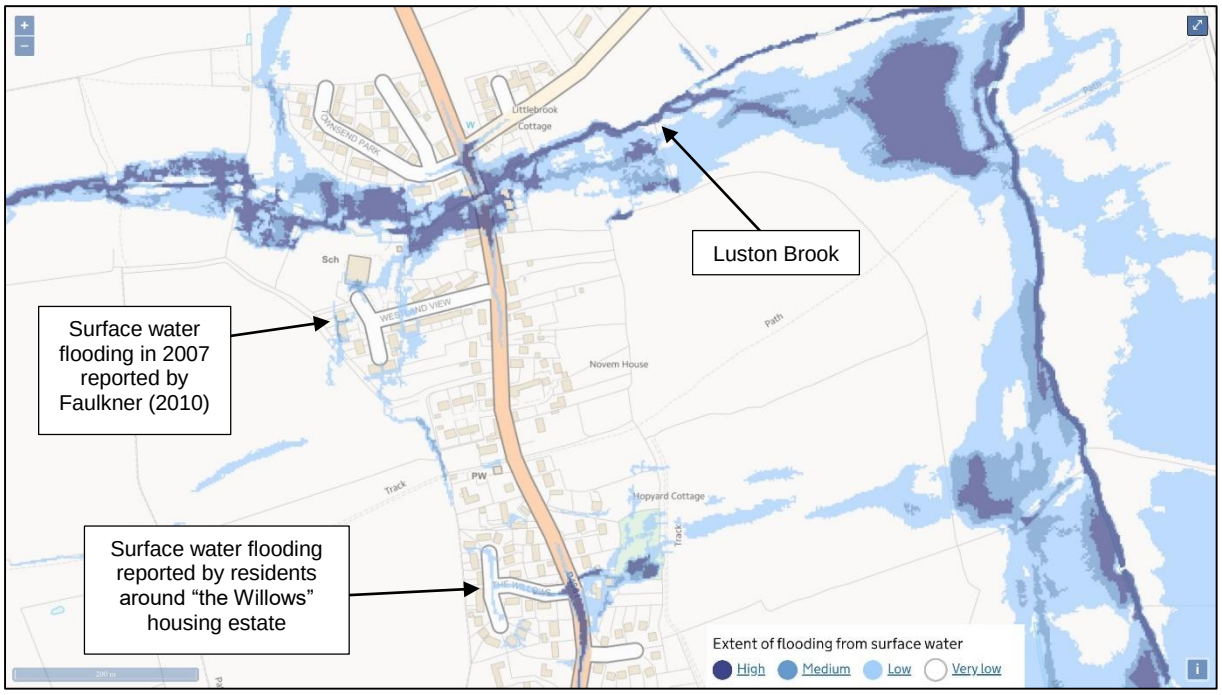
Surface water flooding may occur due to rainfall runoff from impermeable or saturated surfaces. The water flows overland and pools in low areas, according to local topography. The flow and ponding of surface water can create flood risk to people and property. The Environment Agency Risk of Flooding from Surface Water Map attempts to model where risk exists based on topography.

Due to the modelling techniques used, the mapping picks out depressions in the ground surface and also simulates flow along natural drainage channels. Although the map appears to show flooding from ordinary watercourses, they should not be taken as definitive mapping of flood risk from these, since the conveyance effect of structures on ordinary watercourses (such as bridges, culverts and weirs) are not represented.[7]

The extent of flooding from surface water for the area around Luston is mapped in Figure 12. Instead of assigning areas into flood zones it uses a four-point scale of "high", "medium", "low" and "very low" flood risk, in which "high" indicates high probability, the most likely to occur rather than high intensity. The definition of each category of surface water flood risk is listed in Table 1.

Figure 12 shows areas along the brook that are at the greatest risk, together with routes identified as overland flood flow paths, which follow roads or other ground features. The surface water flow routes indicated in the map are supported by local residents' descriptions of flow paths of surface water runoff during storm events and those outlined by Faulkner (2010), this is discussed further in Section 4.

Figure 12 Environment Agency Surface Water Flood Extent Map



Source: https://check-long-term-flood-risk.service.gov.uk/map?easting=348515&northing=263179&map=SurfaceWater

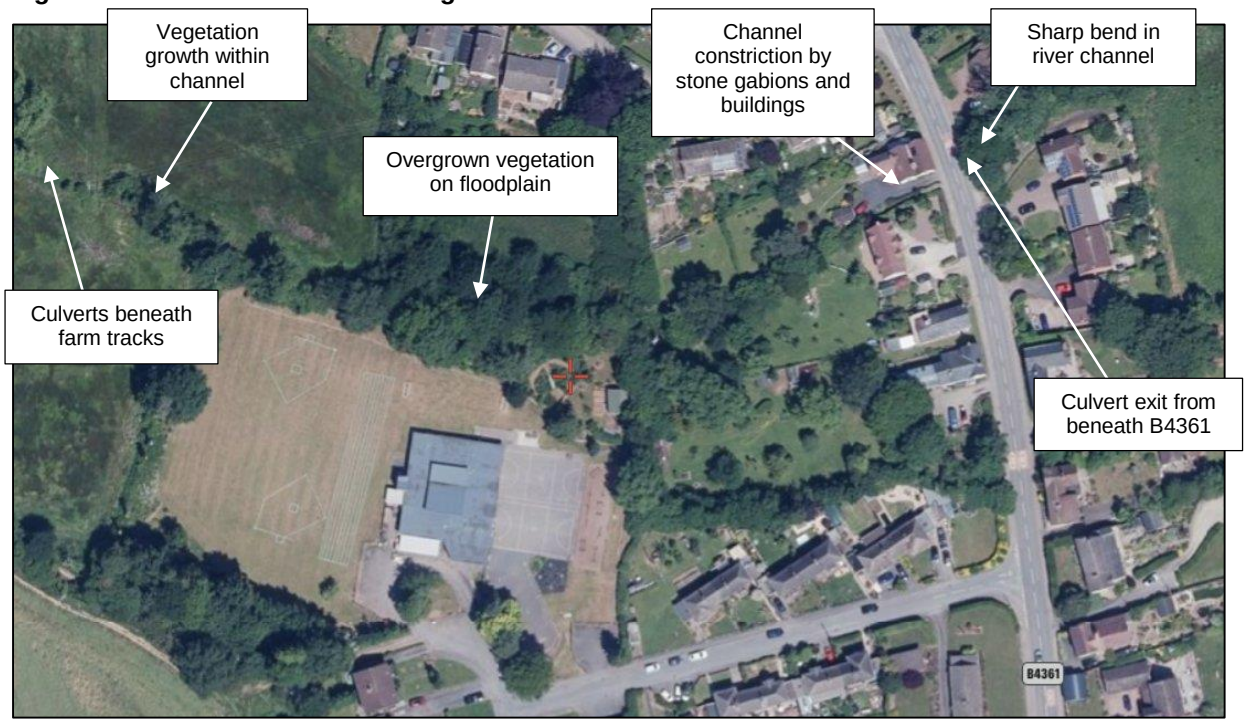
[7] Environment Agency, What is the risk of flooding from surface water map? Version 2.0, April 2019 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/842485/What-is-the-Risk-of-Flooding-from-Surface-Water-Map.pdf

Table 1 Flood Risk Categories for surface water flooding[8]

High	Flooding occurring as a result of rainfall with a greater than 1 in 30 chance in any given year (annual probability of flooding 3.3%)
Medium	Flooding occurring as a result of rainfall of between 1 in 100 (1%) and 1 in 30 (3.3%) chance in any given year
Low	Flooding occurring as a result of rainfall of between 1 in 1000 (0.1%) and 1 in 100 (1%) chance in any given year
Very Low	Flooding occurring as a result of rainfall with less than 1 in 1000 (0.1%) chance in any given year

In the fluvial environment, hydraulic concepts are principally considered in context of open channels and structures, or features that either constrain or control the flow. The overall behaviour of flow in a channel depends on the complex interaction of a range of physical, climatological and human controls. Local scale controls identified within Luston could influence channel behaviour, local hydraulic factors include the channel morphology (the physical form of the channel), local modifications and in-channel vegetation. These features and locations are shown in Figure 13 and Figure 14 and are discussed in the following sections of this report.

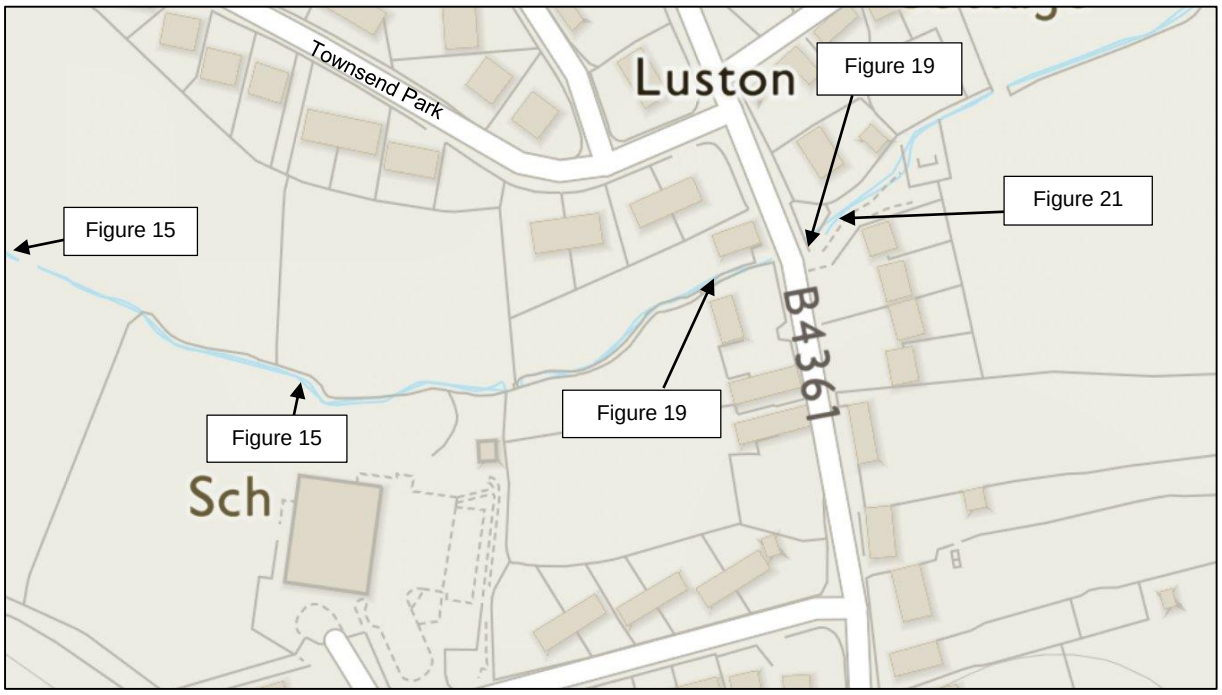
Figure 13 Flood mechanisms along Luston Brook



Source: https://satellites.pro/UK_map#52.265315,-2.754764,19

[8] Environment Agency, What is the risk of flooding from surface water map? Version 2.0, April 2019 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/842485/What-is-the-Risk-of-Flooding-from-Surface-Water-Map.pdf

Figure 14 Luston Brook through the village, including location of photos in following figures



Source: https://osmaps.ordnancesurvey.co.uk/52.26630,-2.75473,15/pin

3.2 In-channel and floodplain vegetation

Luston brook flows easterly as an open channel towards the village (Figure 15), it passes through culverts beneath field entrances (Figure 16). In the open-channel sections there is significant in-channel vegetation with some area of recent vegetation clearance. In sections of the floodplain there is uncontrolled vegetation growing along stretched of the floodplain, as seen from the Primary School grounds, in Figure 17.

Local channel features that influence conveyance can include in-channel debris, which can reduce the channel capacity to convey flow, this reduced conveyance capacity, increases water levels for a given flow. Surface roughness provides the primary resistance to the flow in the absence of blockage. In-channel vegetation will result in greater resistance, slowing flow and increase water levels. Excessive in-channel and floodplain vegetation growth can promote sedimentation accumulation within the channel leading to significant loss of conveyance and raise upstream water levels.

Figure 15 Luston Brook upstream of the village, looking west

Figure 16 Culvert beneath field entrance track

Figure 17 Floodplain vegetation and debris on the left bank of Luston Brook

3.3 Channel Constriction

The brook flows south of Townsend Park and along the northern boundary of Luston Primary School. As the brook flows into the village, the channel is constricted between property boundaries (Figure 18). Near-vertical channel walls are formed of rock aggregate, held in place by steel wire and known as “Gabion baskets”. At this location, about 50 m upstream of the B4361 road culvert, they reduce the channel to approximately 1.2 m x 1.2 m (Figure 19).

This section of the channel is significantly narrower than the culvert (measured at 1.7 m wide at river level, Figure 21). Under high flow or flood conditions, the narrowed section of channel would cause water levels to rise and and these could overtop the banks. Once released from the constraint of the banks, floodwaters would be free to follow variations in the local topography and flood low-lying land. Such overland flow tends to be guided by local features and as shown by the dark green shading in Figure 20, there is a significant area along the B4361 where ground levels are below about 76.2 mAOD.

Flooding from watercourses occurs when flows exceed the capacity of the channel, or where a restrictive structure is encountered, which leads to water overtopping the banks into the floodplain. The change in the channel cross-section along this section will have an effect on the conveyance capacity of the channel and during a high flow event, it is likely to form a local control and influence the behaviour of the brook upstream and downstream.

Figure 18 Luston Brook channel constriction upstream of culvert

Figure 19 Luston Brook channel constriction upstream of culvert, including measurement

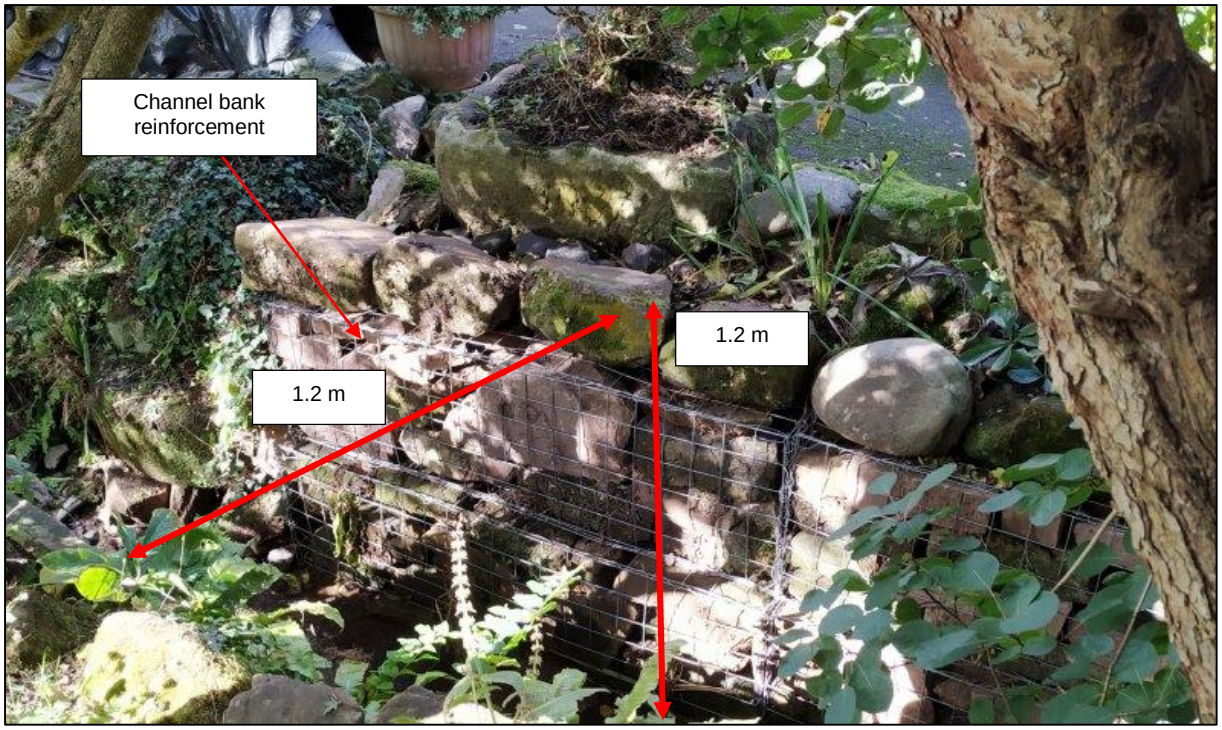
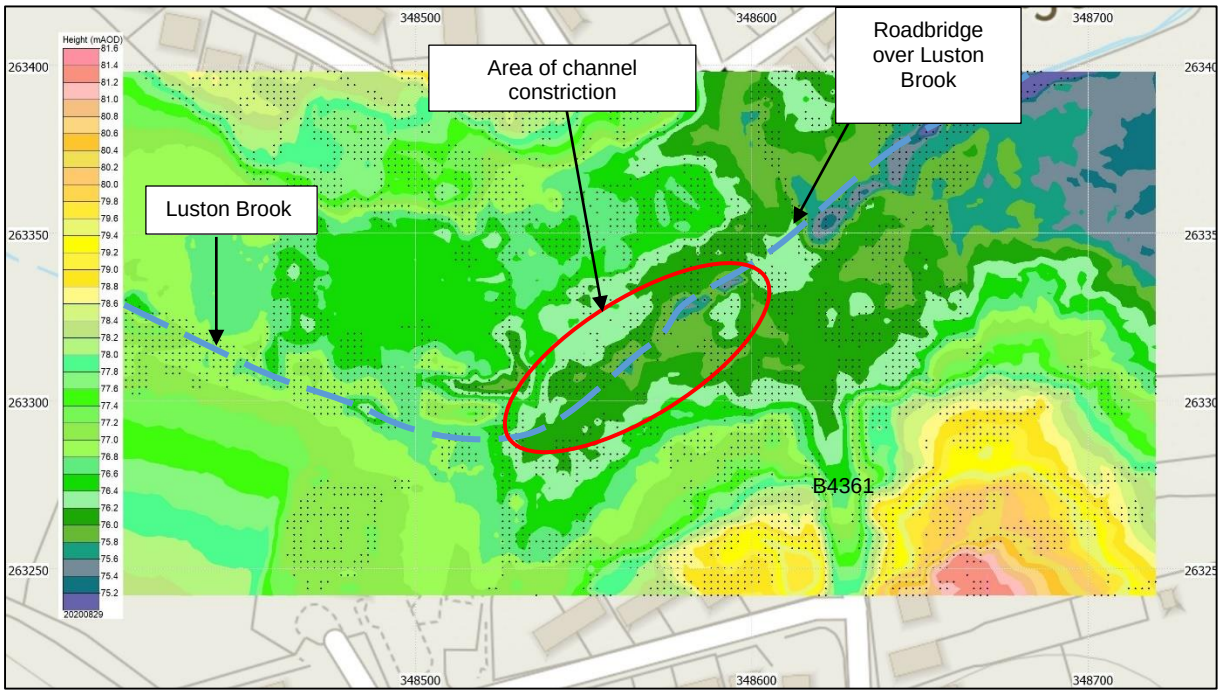


Figure 20 Layer coloured shaded topography around Luston Brook



Layer interval 0.2 m

3.4 Channel changes

The brook flows through a box culvert beneath the B4361, with an arched roof. As shown in Figure 21, the width was measured at 1.7 m at water level, with a maximum height of 1.1 m. As the brook exits the culvert, flow is diverted by stone walls (Figure 21) which cause channel flow to take a sharp bend, to the north and then east (Figure 22), before returning to an open channel with grassed banks (Figure 23). Inflow culverts were visible at the road bridge, which are presumed to manage road drainage from the B4361. The brook continues to flow east away from the village, through agricultural land (Figure 23), before joining a tributary of the River Lugg, approximately 600 m east of the village.

Seen under low-flow conditions in Figure 21, the discontinuity created by this zig-zag bend does not appear to cause significant disruption to flow. Under high flow or flood conditions, the effect is likely to be significantly more disruptive. After maintaining or perhaps increasing flow velocity through the straight culvert section beneath the road, water meeting an obstacle such as this would be forced upwards, with a dramatic increase in turbulence. The effect is likely to be chaotic and very difficult to quantify but the increase in water depth caused by the local reduction in downstream velocity would be expected to extend well beyond the obstacle itself. Given the constraint provided by the culvert upstream, the effect of this zig-zag bend is likely to extend upstream to the west of the main road, the B4361.

The cumulative impact of multiple factors can play a significant role in channel dynamics. For example, sediment inputs upstream may not significantly impact conveyance, but this factor, coupled with excessive vegetation growth, blockage downstream and channel constrictions may, act together, resulting in conveyance issues.

Figure 21 Culvert exit beneath B4361 with approximate measurements

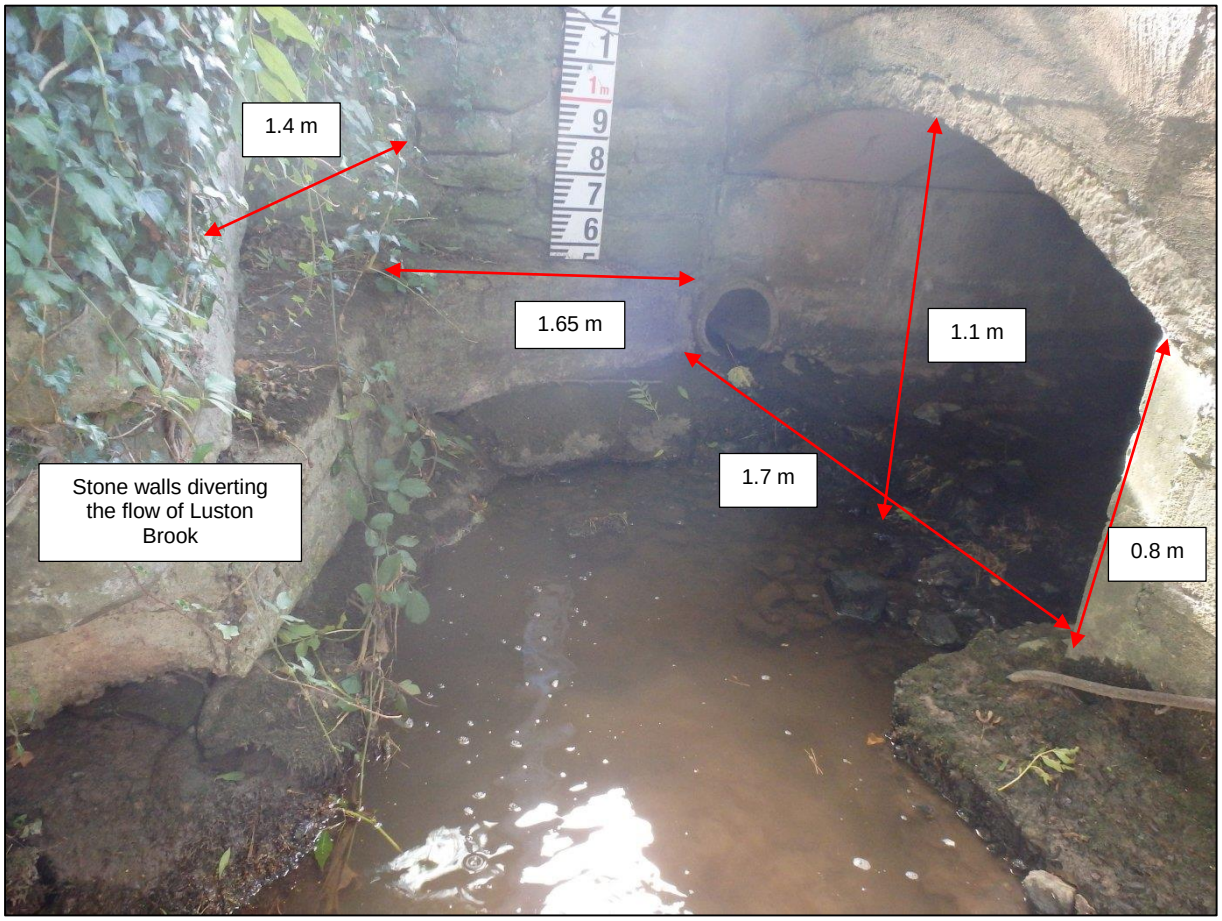


Figure 22 Flow path downstream of culvert

Figure 23 Luston Brook downstream of culvert, adjacent to The Fold

4 Flood Risk associated with Surface Water

Surface water flooding can occur during prolonged or intense storm events when the infiltration potential of soils, or the capacity of drainage infrastructure is overwhelmed leading to the accumulation of surface water and the generation of overland flow routes. The Environment Agency surface water flood map (Figure 12), shows areas in dark blue which are at high risk of surface water flooding. High risk is defined as greater that a 1:30-year return period. This map does not take into account the presence of watercourses, sewers or other drainage features that may convey water efficiently and is only indicative of areas at risk of surface water flooding.

4.1 The areas affected by surface water flooding

The surface water flood extent map in Figure 24 is based on the Environment Agency's evaluation of long term flood risk in England[9]. These maps do not provide information on how likely it is that an individual property will flood. They are based on topographic and other general catchment data and should be regarded as a starting point in any investigation. In that context, Figure 24 picks out the main flood flow paths that can affect the western margin of the village. For ease of reference, they are numbered 1 to 4 in Figure 24.

1) Surface water flowing towards the north is diverted eastward, towards Luston Primary School. Having passed through the school grounds, floodwaters enter Luston Brook.

2) Another flood flow path towards the north is diverted into the houses to the south of Westland View. After crossing this road, it continues on to Luston Brook.

3) Towards the south of the village, a flood flow path is shown in Figure 24 to enter the estate of houses known as The Willows.

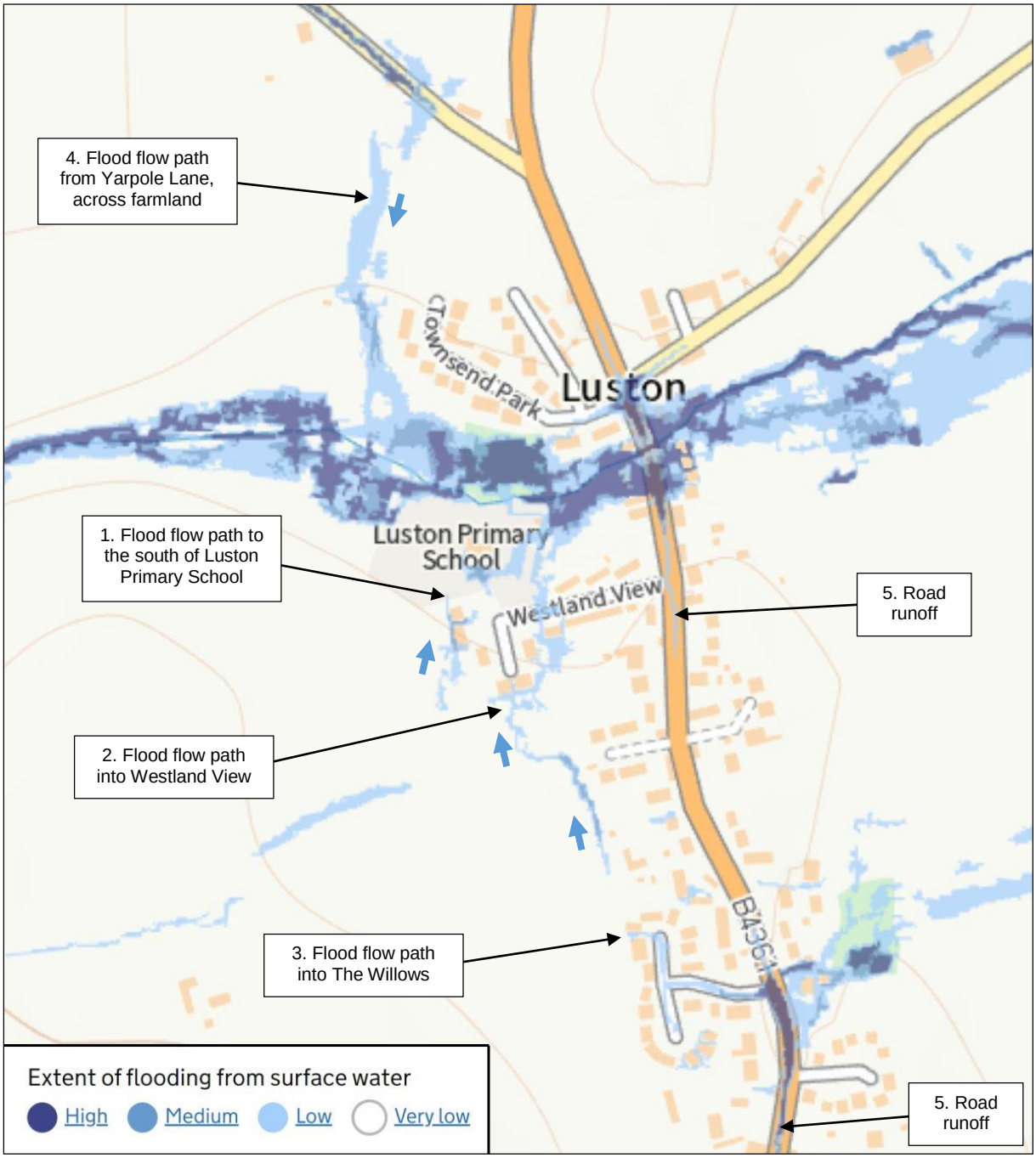
4) Floodwaters may flow along Yarpole Lane, towards Luston, before being diverted to the south, across agricultural land. People do not appear to be put at risk from this flood flow path, which is not considered further in this report.

5) Road runoff is typically derived from surface water sources. Two labels in Figure 24 show runoff along the B4361, one from a source beyond the southern margin of the village, with runoff also marked south of the Luston Brook culvert. Highway drainage usually manages runoff to the 1:5-year return period[10] beyond which, less rigorous requirements are applied. Although it may contribute to flooding within the village, this source of flooding is not considered further in this report.

Flood risk associated with the first three of these flood flow paths is described in further detail below, after which possible mitigation is recommended.

[9] https://www.gov.uk/check-long-term-flood-risk
[10] https://www.standardsforhighways.co.uk/prod/attachments/ada3a978-b687-4115-9fcf-3648623aaff2

Figure 24 Surface water flooding affecting Luston's western margin



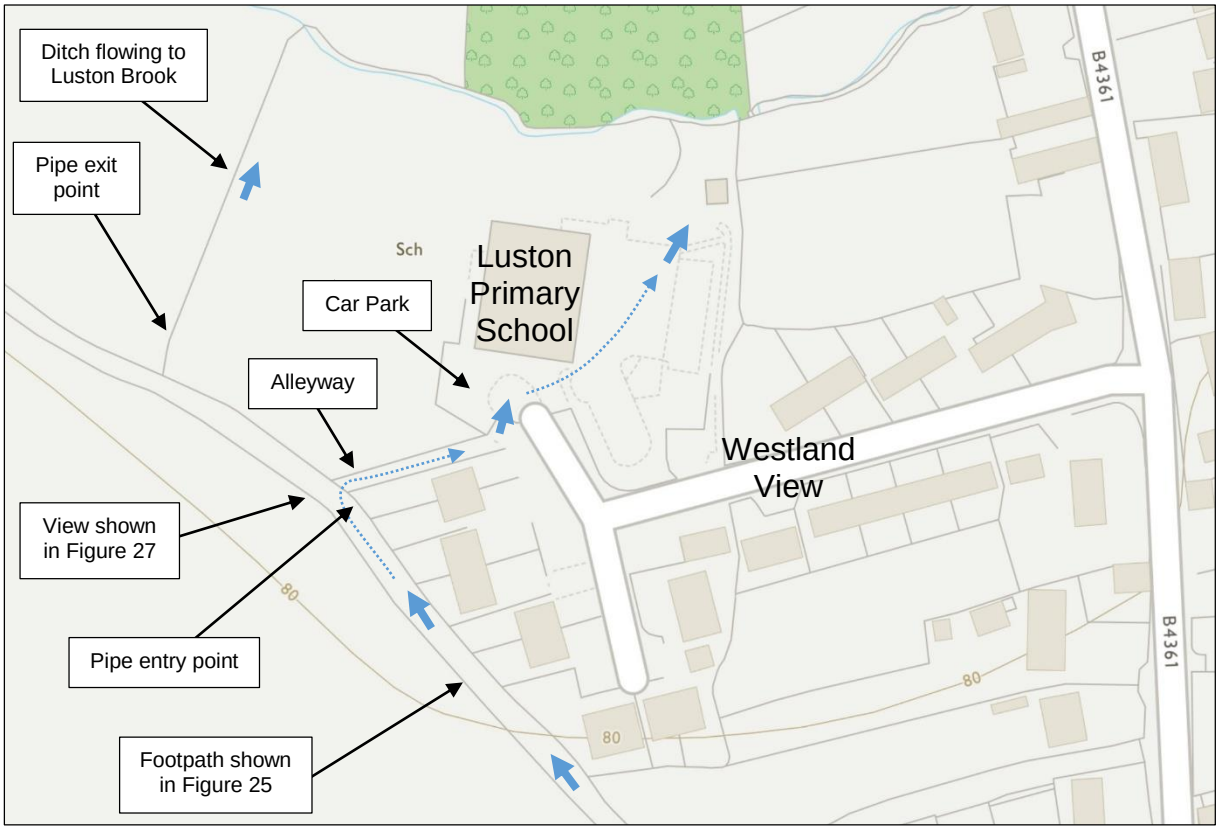
4.1.1 Luston Primary School

The surface water flood extent map in Figure 24 does not correctly represent the detail of this flood flow path. This map suggests that floodwater from the south flows between dwellings to the south of the school, after which flooding is not shown on Figure 24 but resumes again to the immediate south of the school. This does not accord with the topography or with witness accounts. Floodwater is diverted along the footpath to the west of the dwellings but cannot pass between them, due to raised ground (Figure 25).

Figure 25 View from the west of the school, looking south in January 2021

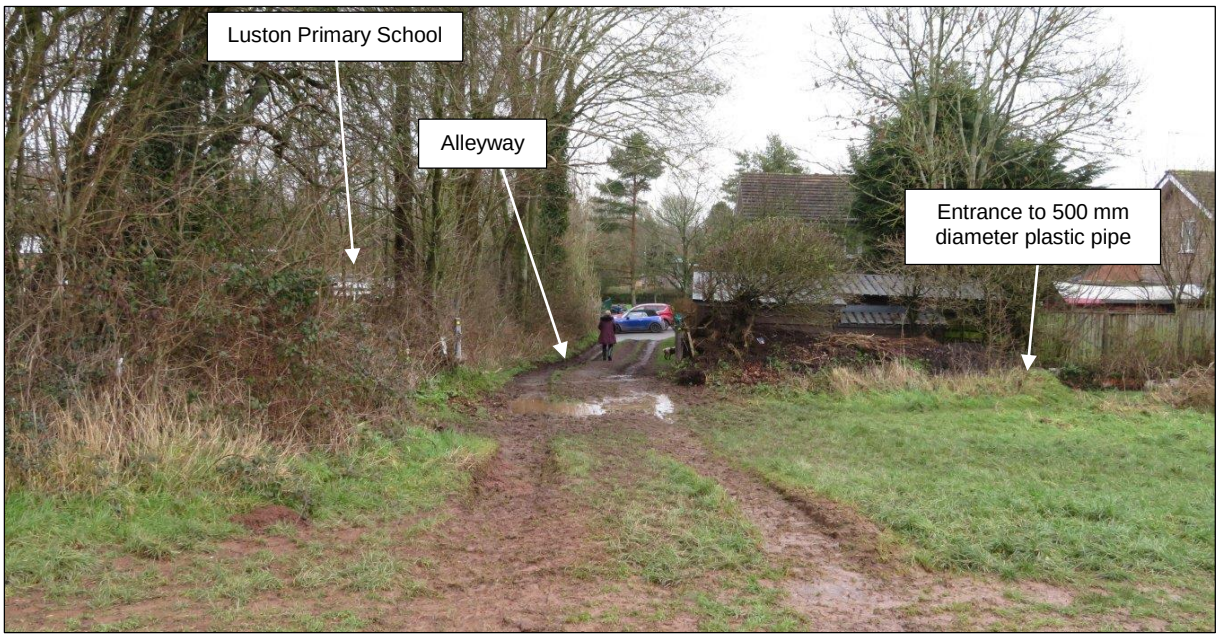
As shown in Figure 26, this footpath continues on towards the north west, forming the south western boundary of the school grounds. Instead of taking that route, small differences in ground level divert floodwaters eastward, where an alleyway leads down towards the school entrance (Figure 27). It can be seen from Figure 27 that the alleyway is used by vehicles to enter the field and that water had accumulated at its entrance, some time before the photo was taken, in January 2021.

Figure 26 Flood flow paths, as described by witnesses to the February 2020 event



Note: Blue arrows indicate the approximate route of floodwaters, as reported by witnesses

Figure 27 View along the alleyway, the flood flow path used in February 2020



There is evidence of an attempt to mitigate flood risk in the past. A 500 mm diameter plastic pipe has been laid through the school grounds, near their south western boundary. Flow can enter the pipe near the end of the footpath shown in Figure 25, to the right of the alleyway in Figure 27. As shown in Figure 28, a trash screen has been fixed across the entrance to this pipe, although leaf litter and other small detritus is presumably able to enter.

Figure 28 View to the north west, along the footpath mapped in Figure 26

The exact route is not known but the downstream end of this pipe is about 80 m to the north west, where it discharges into a ditch, leading to Luston Brook (Figure 29). Although this pipe provides a route that can divert water away from the school, it is also able to block and, since it is very difficult to inspect, may already contain significant detritus that impedes flow. One witness informed us that the trash screen had trapped significant vegetation during the February 2020 event and may have contributed to flooding at the school.

Figure 29 Pipe discharging into a ditch leading to Luston Brook, January 2021

4.1.2 Westland View

The map of surface water flood extent (Figure 24) shows a second route from the south, which is diverted into the houses bounding Westland View. Once again, information provided in the map (Figure 24) differs in detail from the evidence on the ground. When visited, in January 2021, a ditch was conveying water along the western margin of the recent estate of houses known as Mortimer Meadow and located in Figure 30. This flow was augmented by at least one small ditch, flowing from the west (Figure 31).

On reaching the footpath the northward-flowing ditch in Figure 31 is diverted along the footpath for a short distance (Figure 32), before turning back towards the north, into an area of gardens to the south of Westland View (Figure 33). These gardens were not readily accessible and flow could not be traced through them. The surface water flood extent map however (Figure 24) suggests that floodwater would flow between these houses, which suggests that some of them could be affected by flooding.

Figure 30 Map showing flood flow paths leading into Westland View

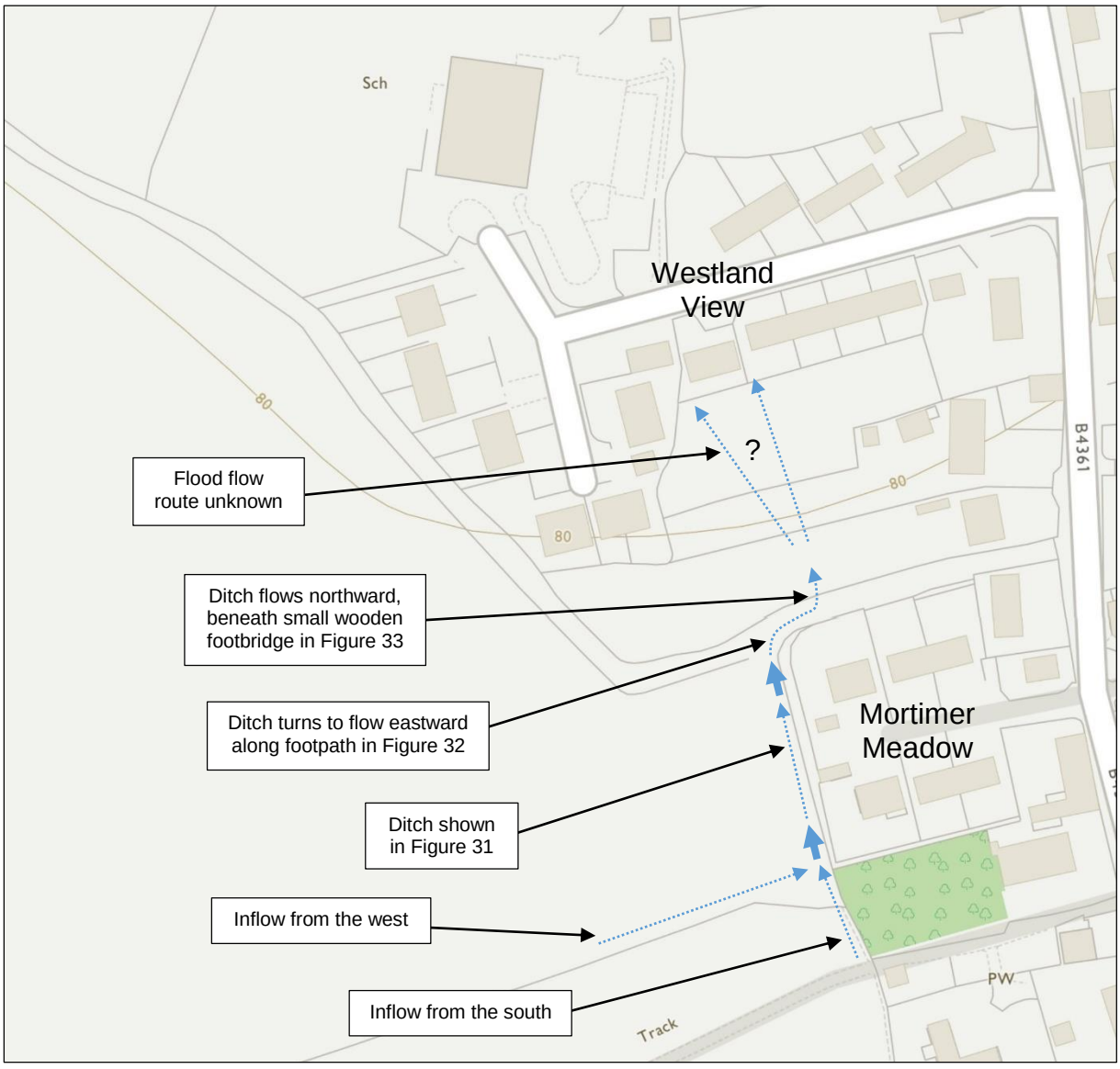


Figure 31 Fed from the north and west, a ditch flows past the west of Mortimer Meadow

Figure 32 Joining the footpath, the ditch takes a path beneath a wooden footbridge

Figure 33 Flow leaves the footpath, flowing into private gardens to the north

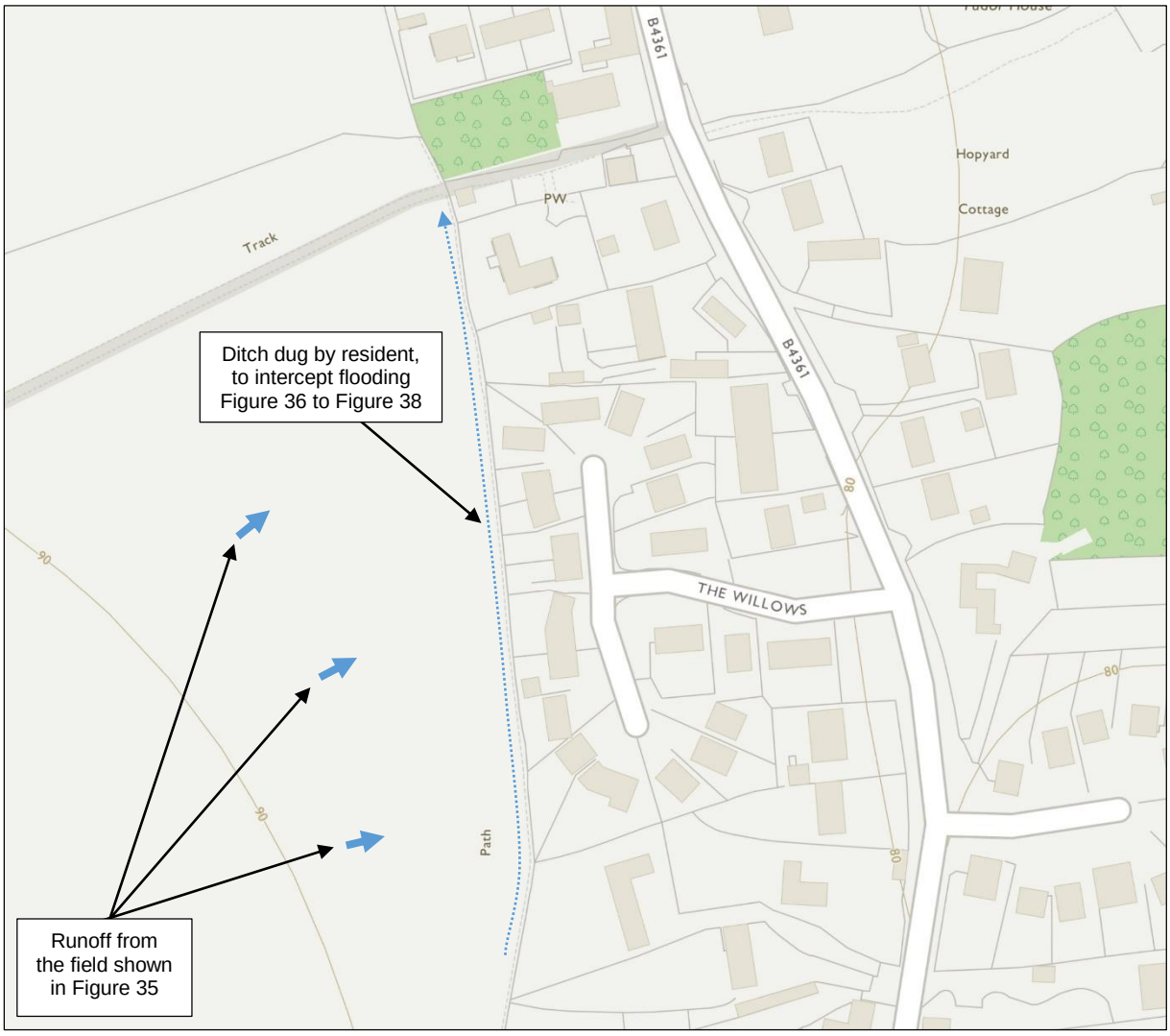
The structures created to manage flood risk on the western margin of Mortimer Meadow are worthy of comment. It can be seen from Figure 31 that a concrete wall has been established, rising about 1 m above ground level. A line of trees has been planted at the base of that wall and outside the curtilage of the development. It is envisaged that in due course, a network of roots will develop, which will help to stabilise the bank and the wall above it, providing a measure of protection against erosion and / or collapse of the bank, by the flood alleviation channel at its base.

A down-side of the flood alleviation measures already in place west of Mortimer Meadow (Figure 31) and upstream, bounding The Willows (Figure 36, Figure 37 and described in the next Section), is that any flow captured by these channels will be routed along the section of footpath shown in Figure 32 and into the gardens to the south of Westland View (Figure 33). Measures put in place to mitigate surface water flood risk to the south may be having the unintended consequence of increasing it in another part of the village.

4.1.3 The Willows

The map of surface water flood extent (Figure 24) shows a flood flow path from the west, which joins the northern tip of the road system within “The Willows”. The road system within The Willows is coloured in a light shade of blue, indicating low levels of flood risk, which becomes dark blue at the main road, the B4361. Some of the dwellings at the southern end of The Willows are shown as having surface water flood risk between them and the dark blue colour extends to the east of the main road, with flooding shown around some dwellings.

Figure 34 Map showing The Willows and the existing drainage system



The source of flood risk at The Willows is clear to see (Figure 35), it is the agricultural land to the west. During the site visit, a resident approached to offer his assistance, he explained that flooding had been problematic in the past but the land owner of the catchment to the west had been approached. Although he was not able to dig the ditch himself, he did give permission for a local man, who had access to a mechanical digger, to create the ditch that can be seen across the field margin, bounding the gardens in Figure 36.

This section of the ditch was seen to be conveying shallow water and a short distance to the north, this same ditch could be seen to be approaching bank-full. The reason for this could be seen in Figure 36 and an enlarged photo (Figure 37), where partial collapse of the ditch margin has created an element of blockage.

Figure 35 Catchment draining to The Willows, open agricultural land to the west

Figure 36 Dwellings on the western margin of The Willows, sunk down below their gardens

Figure 37 A section of The Willows' ditch, almost at bank-full in January 2021

Figure 38 Partial blockage of the ditch protecting The Willows

5 Flood Alleviation Recommendations

5.1 The Herefordshire Flood Alleviation Strategy, Faulkner (2010) Recommendations

The Herefordshire Flood Alleviation strategy (Faulkner, 2010) outlined feasible flood alleviation measures for the village of Luston. It was identified that separate schemes were required for the flooding on the B4361 and adjacent properties and for the flooding occurring in Westland View, due to surface water flooding. Faulkner (2010) recommended the following schemes:

Scheme 0 – Do Nothing – The only requirement outlined was for the riparian owner on the left bank at Townsend House to remove all vegetation along the channel which will be restricting flow.

Scheme 1 – Improve approach channel at B4361 Bridge – the report attributed much of the flooding at the B4361 to be due to reduced capacity of the channel upstream of the bridge. The recommendation was to enlarge the channel for a distance of 35 m, increasing the top width by 1.5 m (0.75 m on each bank) and dredging the existing channel to a depth of 0.2 m. The properties benefiting would be Townsend House, Ashfield Cottage, Ashfield, 1 to 4 The Fold and 1,3,5 and 7 Townsend Park.

Scheme 2 – Interception trench and new channel to rear of Westland View – recommendations for:

- 2 m deep x 2 m wide gravel back filled interception trench for 60 m at the base of the hill behind 7 to 12 Westland View;
- A 10 m 675 mm diameter pipe is required to maintain access into the fields.
- The pipe would discharge directly to a 130 m length, 2 m wide x 0.75 m deep continuation ditch, that follows the western boundary of the school games field to discharge directly into Luston Brook.

This scheme would provide protection to the properties at 7 to 12 Westland View as well as Luston Primary School.

5.2 Further recommendations and guidance

The following measures are intended for consideration for flood alleviation within the village of Luston, based on the causes and consequences of flooding as described in Sections 3 and 4. The potential measures are separated into three sections, those associated with flood risk from Luston Brook, those associated with surface water flood risk from surface water and catchment based options. The following flood alleviation recommendations also build on the measures recommended in Faulkner (2010) and are considered and discussed further within this section:

1. Channel improvements along Luston Brook to increase capacity;
2. Improvements to floodplain management along the brook;
3. Construction of a Flood alleviation channel to west of the village;
4. Land Management improvements within the catchment;
5. Natural Flood Management measures upstream of the village;
6. Individual property level protection measures.

5.3 Flood Risk associated with Luston Brook

A) Channel improvements Luston Brook to increase capacity

Description:

1) In order to increase capacity and conveyance of flood flows along Luston Brook, it is recommended that channel improvements are made upstream of the culvert and between two properties. The channel at this point is constricted to a width of 1.2 m by stone banks (Figure 18) and it is recommended that the channel width along this stretch is increased to remove this local constriction. The channel dimensions should be similar to the channel downstream of the culvert, to manage rising water levels and allow flood flows to flow freely downstream towards the culvert.

2) Another measure that should be considered in conjunction with the upstream channel width increases, is the removal of the sharp bend within the channel, downstream of the culvert. Flow leaving the culvert follows a convoluted course, being diverted by a stone wall, as shown in Figure 22. This flow route impedes conveyance during a flood event and will increase flood levels upstream. Replacement of the stone walls with a structure that is better aligned with flow would help maintain the downstream velocity of the floodwater.

Flooding Addressed:
Flooding from Luston Brook around the culvert beneath the B4361.

Area of benefit:
Road and properties close to the culvert beneath the B4361.

Flood impacts addressed:
This scheme would reduce the frequency and severity of flooding arising from Luston Brook and affecting the B4361 and nearby properties. It is anticipated this would reduce the frequency of high flood depths to the main road. Both measures require co-operation with local property owners, given the proximity of properties and driveways to the brook. The householder adjacent to channel constriction showed a willingness to widen the channel along their property boundary, but this would need to be done in coordination with work downstream of the culvert, to ensure maximum benefit to the village.

Maintenance:
Once the work has been undertaken no further maintenance will be required.

Risks and Constraints:
Residential properties and access driveways are on both banks of the brook, these will constrain the extent to which the channel can be widened.

B) Selective management of in-channel and marginal vegetation.

Description

It is recommended that maintenance of vegetation within watercourses and drainage features is improved along Luston Brook, providing the following benefits:

- **Manage debris:** Vegetation growth on the banks of a channel can be a significant source of debris including fallen leaves, dead stems and fallen branches. This can impede floodplain flow paths and once in the channel, can promote blockage.
- **Maintain conveyance:** Dense growth of vegetation in a channel can reduce conveyance, reduce flow energy and promote sedimentation

Cutting emergent vegetation involves removal of marginal vegetation that grows above the water line but it may have it roots in the water. The emergent or marginal vegetation usually grows on the channel margins and on the banks. It is recommended that cutting is carried out during the late summer/autumn months to increase the conveyance of water in the channel[11].

Flooding Addressed:
Flooding from Luston Brook.

Area of benefit:
This will benefit properties adjacent to Luston Brook and the B4361.

Flood impacts addressed:
Management of vegetation will improve conveyance of floodwaters and mitigate the risk of blockage of the culvert within the village.

Maintenance:
Where a watercourse passes through an area of private land the responsibility for its maintenance passes to the riparian owner of that land. Under riparian water rights[12], the owners of the land up to the centreline of the watercourse have duties to:

- let water flow naturally without obstruction, pollution or diversion affecting the rights of others;
- maintain the bed and banks of the watercourse and to clear any debris, whether natural or man-made;
- keep any culverts and rubbish screens clear of debris;
- be responsible for protection of your land from flooding, and to not cause any obstructions;

Risks and Constraints:
The frequency of in-channel vegetation and planned maintenance programme needs to be planned, as over-clearing of vegetation can have consequences. Riparian vegetation can also increase the cohesion of river banks making them less sensitive to erosion.

[11] Environment Agency, Channel Management Handbook. Report SC1100002, 2015. Available from: https://www.gov.uk/flood-and-coastal-erosion-risk-management-research-reports/channel-management-handbook-for-flood-risk-management
[12] https://www.gov.uk/guidance/owning-a-watercourse#owners-your-responsibilities

5.4 Flood Risk associated with flooding from surface water

A) Flood Alleviation Channel

Description

In order to manage surface water runoff from the hillslope catchment to the west of the village, it is recommended that a flood alleviation channel is constructed. Designed in a similar way to that already in place bounding The Willows (Figure 36, Figure 37) the flood alleviation channel would serve the purpose of intercepting surface water runoff and diverting flows around the western edge of the village north, towards The Luston Brook. By extending the channel already in place at The Willows, this scheme aims to extend that benefit by diverting floodwaters that could otherwise reach Westland View and Luston Primary School.

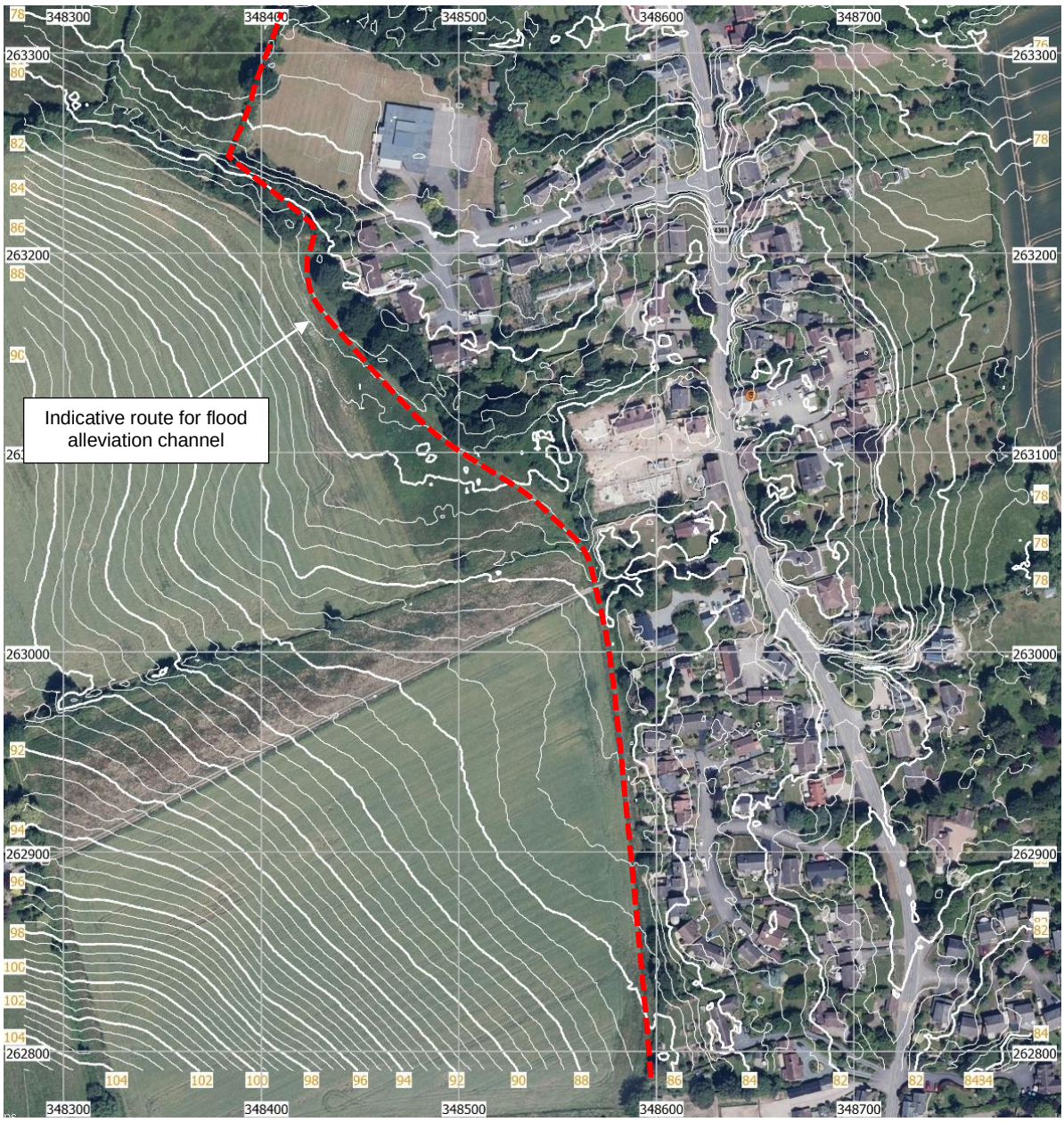
An indicative route for the open channel flood alleviation channel is shown in Figure 39. Extending and enlarging the existing ditch to the west of The Willows and continuing it further south, around the wooded area to the west of the footpath shown in Figure 25. In this way, the section of the ditch to the west of Mortimer Gardens is bypassed and the flow into Mortimer Gardens, shown in Figure 32 and Figure 33 would be significantly reduced. This would reduce flood risk in Westland View, as well as improving conditions along the footpath. By plotting a suggested route over an air photo, with contours printed over it at a 0.5 m interval, it can be seen that a route should be available that has little or no impact on the woodland, but is able to convey flow in a consistently downstream direction.

Having reached the location to the south west of the school, where a 500 mm pipe is in place to convey floodwater to the western limit of the school grounds, it is recommended that the current system is modified. Low rates of flow along the footpath, such as that shown during January 2021 (Figure 25) can probably be managed by the existing system. The purpose of this pipe however is to manage moderate to high flow rates and protect the school from future flooding. In this regard, the pipe has failed once and although discharge along the footpath is expected to be reduced by the recommended alleviation channel, there remains the possibility of future blockage, within the pipe or at its entrance.

Closed pipes are inherently unsuitable for tasks such as this and an open ditch is the recommended alternative. Although the route of the pipe could not be traced, it clearly conveys flow, as evidenced by the limited outflow in January 2021 (Figure 29). If it were removed, it should be possible to construct an open ditch along that same route. The first part of the ditch would need to pass beneath the alleyway and a limited stretch of culvert, long enough to convey flow beneath the field entrance may be appropriate. Beyond that, the course of the pipe is believed to pass through the woodland, where the channel would be located. A pipe may be appropriate for the final section, beneath the school margin.

The channel design would need to reflect the terrain through which it passed. By following the existing route within the woodland, disturbance to trees should be minimised and their roots should come to stabilise the channel margins. If a route was required through the western corner of the field, the channel could be broad and shallow and covered by grassy vegetation. The channel margins can be gently-sloping berms, rather than steep bunds, making it safe to enter, at least during dry weather and preserving the visual aspects of the playing field.

Figure 39 Indicative route for flood alleviation channel to the west of the village



Source: Google satellite image with 0.5 m contours

Detail concerning the depth of the recommended ditch has not been considered here. The existing 500 mm pipe is currently concealed below the surface, making it likely that a 500 mm deep ditch would fit within the constraints imposed by the site. It may be necessary to build up the channel banks, particularly along their down-slope, north eastern margin and unlike a pipe, a ditch can be made wider and less deep, where the situation demands. The narrow ditch cut through the soil bounding The Willows appears to support relatively vertical sides (Figure 37) but has led to at least one, minor collapse (Figure 38) and the broader and deeper ditch bounding Mortimer Gardens (Figure 31), may be a pragmatic, alternative design along the entire route.

Flooding Addressed:
Surface water flooding from the hillslope catchment to the west of the village.

Area of benefit:
Properties in Westland View and Luston Primary School.

Flood impacts addressed:
This option would manage surface water runoff, redirecting it northward, along the western margin of the village, away from residential areas. It is not expected to have a significant effect on flood risk from Luston Brook.

Maintenance:
It is important to ensure that the flood alleviation channel is kept free of blockage, at a depth sufficient to convey the flow commensurate with a high magnitude rainstorm. It was shown that the ditch bounding The Willows had become partially blocked by a small earth-fall (Figure 37, Figure 38), suggesting that some enlargement of the ditch may be in order, with any excess earth piled up on the channel's eastern margin, to ensure that overtopping would be into the field to the west, rather than gardens and houses to the east.

In order to ensure there is no reduction in capacity of the channel to convey surface water runoff, it is important to ensure a proper maintenance routine is in place. Regular maintenance should include clearing such small land-slips, litter / debris removal, grass cutting and removal of cuttings. It is recommended that a maintenance schedule is established with the various maintenance tasks to be completed as required.

Risks and Constraints:
The indicative route of the flood alleviation channel is based on observation and outline analysis of topography, further detailed investigation is required to confirm whether the topography is suitable along the length of the proposed channel. The indicative route of the channel passes close to wooded areas, both near the field boundary and on the school site. Further investigation to the ecological feasibility is required to minimise damage to the local environment.

This option requires the co-operation of local landowners, with the channel proposed along field boundaries and within the school site. Negotiations with such "third parties" would need to be undertaken and their agreement and cooperation sought.

5.5 Catchment based management options

A) Catchment Land Management

Description

Land management measures are land-based techniques and practices that seek to influence flood generation by reducing the amount of surface water runoff reaching the river network. This can be achieved by improving soil structure, increasing infiltration resulting in increased capacity of the land to store water. In addition, the rate of surface water runoff and soil erosion is slowed, reducing the flood peak and the volume of sediment transferred to the rivers.

During a site visit, in August 2020, it was observed that the surface of local fields had been ploughed with ridges and intervening furrows, aligned approximately east to west. During a flood event, this form of land management would allow the furrows to act as conduits along which floodwater would flow. In order to manage this risk, soil cultivation should align with the contours, rather than up and down field slopes. This method has been found to slow, store and filter water so that they act as barriers to the down-hill movement of floodwaters. It was observed that this method had been used in local fields, seen during a site visit in October 2021.

Figure 40 Local land management observed in August 2020

Flooding Addressed:
Surface water runoff from local fields during rainfall events.

Area of benefit:
Residential properties in Westland View and The Willows.

Flood impacts addressed:
This option would reduce the depths of flooding by retaining runoff within the furrows and slowing the speed of flow towards the village.

Maintenance:
In order to ensure good practice is undertaken within the catchment, awareness should be made to all local landowners with land that drains towards the village and the brook. Once all landowners, land managers and farming practitioners follow this practice, no additional maintenance will be required.

Risks and Constraints:
Land management measures should be used in context and along with other measures, alone they may reduce the peak flood and duration of flooding for extreme flooding, but such measures would not be anticipated to prevent flooding.

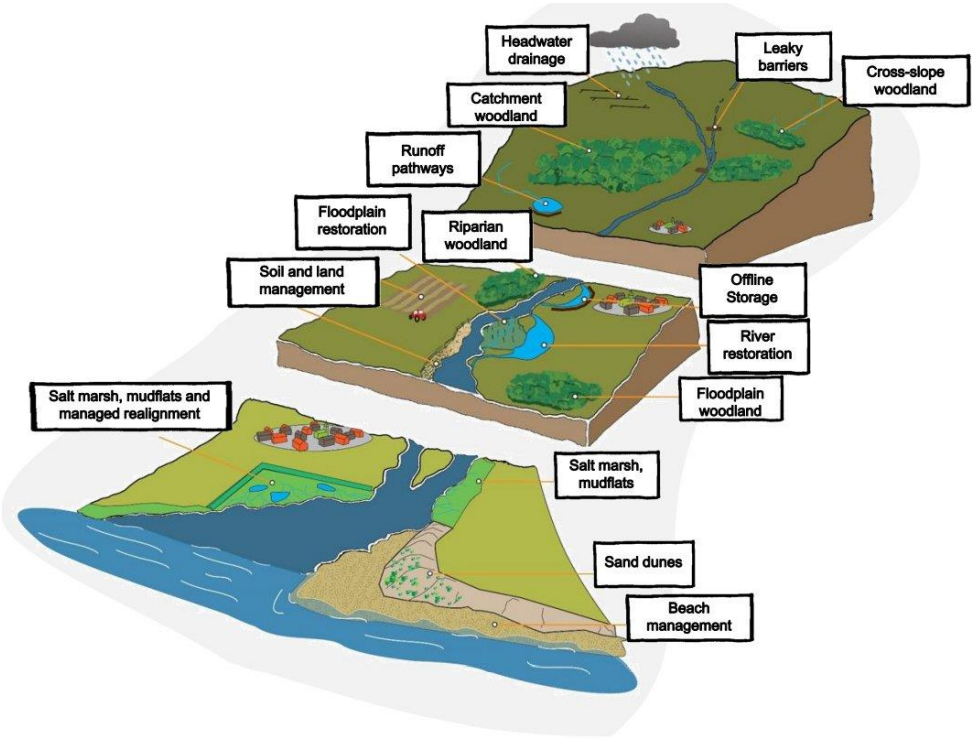
The cost of adjusting soil and crop management practices is typically low but must be considered in conjunction with any effects on yield.

B) Natural Flood Management (NFM)

Description
Upstream of the village, the catchment of Luston Brook should benefit from Natural Flood Management (NFM). This aims to protect, restore and emulate the natural functions of catchments, floodplains and rivers. NFM aims to reduce the maximum water volume of a flood (the peak flood flow) and / or delay the arrival of the flood peak downstream. The diagram shown in Figure 41 demonstrates measures that can be undertaken throughout the catchment to enhance and restore natural processes.

While natural flood management refers to the overarching approach of managing flooding by working with the natural features and processes within a catchment, natural flood management 'measures' are the individual techniques used to deliver that approach.

Figure 41 Natural processes to reduce flood risk[13]



13 https://assets.publishing.service.gov.uk/media/6036c730d3bf7f0aac939a47/Working_with_natural_processes_one_page_summaries.pdf

There are a variety of measures that can be implemented as part of delivering NFM. There are four key, underlying mechanisms by which this can be achieved[14]:

1. Increasing storage: creating temporary storage which will fill up during a flood event and empty slowly (e.g. reconnecting functioning floodplains and creating storage ponds)
2. Increasing catchment and channel roughness: this 'slows the flow' by increasing the resistance to surface and in-channel water flow (e.g. planting trees and hedgerows, restoring meandering rivers and installing leaky dams)
3. Increasing losses: this increases the amount of water that drains (infiltrates) into the ground or is lost back into the atmosphere via evapo-transpiration (e.g. changing agricultural practices to improve soil structure and reduce soil compaction and installing sustainable urban drainage systems (SUDS))
4. De-synchronising peak flows from tributaries: Slowing down one tributary compared to another can significantly reduce flood peaks downstream.

Flooding Addressed:
Flooding along Luston Brook.

Area of benefit:
This option aims to increase flood storage upstream of Luston, the speed and extent of flooding may be reduced by increased storage and slowing the flow of floodwaters along the brook.

Flood impacts addressed:
These measures aim to reduce the rate or amount of runoff and/or improve the ability of the river and their floodplains to manage floodwater. Some measures, such as leaky barriers, can reduce flood risk by intercepting the flow of water in a river, helping to restore river-floodplain connectivity which can reduce flood peaks, slow water velocities and attenuate flow by storing water on the floodplain[14].

Natural Flood management aims to reduce the downstream maximum height of a flood (flood peak), reducing the scale and impact of a flood. Delaying the arrival of the flood peak downstream can increase the time downstream residents have to prepare.

Maintenance:
There are many different options for Natural Flood Management and measures are recommended depending on the catchment characteristics. Once the measures are in place, some require very little further maintenance.

Risk and Constraints:
These measures will require landowner co-operation in the upstream catchment of Luston Brook. Engagement should take place with landowners and other stakeholders, providing evidence of the benefits of these measures to the whole catchment.

[14] https://catchmentbasedapproach.org/learn/what-is-natural-flood-management/

C) Individual Property Flood Resilience (PFR) Measures

Description

To protect properties at risk from flooding from fluvial and surface water sources measures can be installed at an individual property level. Individual property measures can be separated into Property Flood Resilience (PFR) resistance measures, which are designed prevent the ingress of water into a property and PFR recoverability measures, where materials, products and construction methods that are used ensure a property can quickly be made habitable after a flood event. An initial property survey is undertaken to identify the routes of water ingress into a property and then recommends the measures required. Example of techniques for both measures include:

- PFR resistance: includes flood doors and windows, flood barriers, airbrick covers, self-closing airbricks, flood walls, water resistant plaster, non-return valves on drains, toilet bungs, sump pumps.
- PFR recoverability: include raised electric sockets and utility meters, solid concrete flooring or tiling, non-porous paint, waterproof coating to walls and floor, waterproof kitchen fittings.

Flooding Source Addressed:

These measures prevent flood water entering a property or promote rapid recovery from all flooding sources.

Area of benefit:

Properties across the village.

Flood impacts addressed:

This option would potentially reduce the frequency of flooding that occurs to properties and associated flood damages. It would not address impacts associated with flooding to roads and the wider area.

Maintenance:

PFR measures are maintained at a property level and once installed are the responsibility of the property owner. Measures that require manual installation should be stored safely and correctly, with the property owners fully aware the installation method.

Risks and Constraints:

Some measures require a manual installation and require there be a warning of flood risk, so the measures are put in place prior to flooding. Some residents / businesses may not be able to install the measures or may not be at available prior to a storm event and will require assistance.

Where properties are terraced or semi-detached it may require measures to be installed at both properties, to prevent ingress of water between properties.

6 Conclusions and recommendations

This assessment has confirmed the main flood risks to Luston are associated with Luston Brook and surface water flowing from the local hillslope catchment. It is expected that flood risk and impacts will increase in the future as rainfall and river flows increase due to climate change. A range of potential flood alleviation measures have been identified, considering the causes and consequences of flooding in Luston.

A preliminary assessment was undertaken of all identified measures that were considered potentially feasible within the catchment. These included:

- Channel improvements to existing watercourse channel and structures to increase capacity and conveyance;
- Improvements to floodplain and in-channel vegetation management along the brook;
- Construction of a flood alleviation channel to the west of the village;
- Land management improvements within the catchment;
- Natural Flood Management measures upstream of the village;
- Installation of property flood protection measures to prevent inundation by floodwater.

It is recommended that the Parish Council investigate the potential to obtain allocated grant funds to take forward any of the schemes identified above. It is understood that the Parish Council has already engaged with Herefordshire Council regarding their Natural Flood Management programme, via Bethany Lewis, the Natural Flood Management Project Officer, so further details are not required here.

Natural Flood Management is regarded as an important element in reducing flood risk to the village over the medium and long term, measured in decades and beyond. There remains a more immediate need to manage the existing flood risk in the village and this report has identified a set of relatively low-cost measures that we believe would mitigate current risk. In terms of Luston Brook flooding, these are:

1) Remove the obstacle in the channel at the downstream end of the road culvert and replace the bank at that point with less intrusive and better-contoured support.
2) Widen the channel immediately upstream of the culvert, in order to provide adequate conveyance into the culvert and mitigate overbank flow at that point.

For the western margin of the village, a more holistic approach is required that that currently adopted. In particular:

1) Create a flood alleviation channel of adequate proportions along the entire western flank of the village, to convey runoff from The Willows to Luston Brook.
2) Replace the existing pipe with an open channel, mitigating the risk of blockage and allowing inspection and removal of any material that does accumulate.

This is not to suggest that these changes should simply be made, without due thought and consultation. Additional steps are recommended above to help to ensure the support of the community and the success of any proposals. Nor is this to suggest that other efforts to reduce flood risk should be ignored. Far from it, making changes to land management should, over the longer term, provide the context in which Luston will become more resilient to flood risk, through this era of climate change.