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Cost of flooding to Shrewsbury Businesses

Desk Study Preliminary Analysis

Project Name
Cost of flooding to Shrewsbury businesses

Report Prepared for
National Flood Forum

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Findings

This preliminary analysis of the cost of flooding to Shrewsbury businesses demonstrates the significant additional damage and business costs that are not recognised so far in funding applications for flood defences. Additional losses of £14 Million are identified using the Frontier's Toolkit beyond the £25M estimated by the Environment Agency using the prevailing Flood and Coastal Erosion Risk Management Grant in Aid funding formulas used to support Environment Agency/Defra grant applications. Significant further losses are identified (but beyond the scope of this report) takes total losses probably beyond twice those estimated by the Environment Agency. Current funding rules do not allow for their inclusion.

Recognising these damages and losses will lead to better risk management outcomes so a more detailed assessment is recommended to support consideration of flood risk mitigation options for Shrewsbury.

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Summary

Parts of Shrewsbury suffer from frequent river, surface water and groundwater flooding.

Flood damage, business interruption and related costs are a considerable burden on the local economy and the risk is increasing.

Environment Agency Initial Assessment (IA) following significant floods in 2020 did not reach clear conclusions on any cost beneficial scheme to address the problems. The IA concluded that there was no comprehensive mitigation option that would offer sufficient return on investment, and some partial solutions evaluated were marginal and of limited benefit.

However, established methods of economic analysis used by the Environment Agency and Defra do not adequately quantify the cost burden of flooding on business. Economic costs counted by the Agency estimate costs at a national level rather than an individual household, business or local area level. The IA was therefore not able to demonstrate the full costs of flooding in Shrewsbury and provided insufficient basis for evaluation of appropriate solutions to the flooding to meet the needs of the Shrewsbury economy and the local community.

The same limitations, under-representing the impact of flooding on the business community and local economy, prevent adequate assessments more widely across England, and there is a need for a different approach.

Financial losses suffered and likely to be suffered by local businesses operating within the Shrewsbury area of study are significant and it is helpful to quantify these losses in the aggregate to better consider what mitigation measures may be cost beneficial.

Shrewsbury has a higher proportion of independent shops than most towns[1] (for example Wyle Cop, one of the high flood risk streets, has the UK's longest uninterrupted stretch of independent shops) and independent shops are less able to recover from flooding than regional and national chains[2].

In order to better manage flood risk a Shrewsbury Business Flood Action Group (SBFAG) has been established[3]. Shropshire Council successfully secured funding for this project to tackle the challenges posed by flooding to local businesses, and the initiative is a collaborative effort between Shropshire Council, the National Flood Forum and Shrewsbury BID, supported by funding from the West Mercia Local Resilience Forum.

This project aims to quantify business financial losses to identify damage and losses that impact businesses and which are not already recognised in the prevailing Environment Agency analysis.

Not all losses are included in the quantitative economic assessment undertaken by this study. In particular the data analysed here includes premises and operations for existing businesses but does not recognise the wider losses associated with previous business failures. Those businesses which no longer exist are not represented in the data. This is a

[1] https://www.visitshropshire.co.uk/get-shopping-in-shropshire/

[2] https://www.sciencedirect.com/science/article/abs/pii/S2212420922005350#:~:text=Small%20businesses%2C%20which%20contribute%20significantly,and%20skill%20deficiencies%20%5B9%5D.

[3] https://shrewsburybid.co.uk/new-business-group-to-combat-impact-of-flooding-in-shrewsbury/

particular issue in Shrewsbury because of the large proportion of small independent businesses in Shrewsbury, which suffer disproportionately more harm due to less resources and therefore less capability for recovery from flood events, leading to high rates of business failure.

The use of a 'like for like' comparison will help the business community and other stakeholders such as the Local Authority to communicate the business case and enable comparison of mitigation measures for Shrewsbury that deliver the benefit of avoiding such losses. This may also support the business case for partnership funding.

The cost of flooding to businesses includes both immediate tangible losses—such as damage to premises, stock, and equipment—and consequential losses from business interruption and reduced trade. This study considers both categories: (1) physical damage, estimated using national depth-damage databases based on historical flood data, and (2) operational losses during and after flood events, including reduced revenue due to limited town access and footfall, and evidence on the scale and duration of disruption. However, the quantitative analysis is limited by the brief preliminary scope of this first assessment.

Business Losses are mostly NOT included in the prevailing analysis managed by the Environment Agency. This is because from a national standpoint most of the losses incurred during flooding are likely to be made up by deferring purchases or services to a post flood date or transferring these purchases and services to a non-flooded area.

This initial work is a preliminary analysis based on available evidence only and is guided by the 'Light Touch' approaches advocated by the 'Frontier Toolkit' for such work

The Frontier's toolkit method was adopted for this study because it provided an appropriate assessment methodology to quantify the losses due to damage to business premises and business interruption as an additional source of losses relative to the Flood and Coastal Erosion Risk Management Grant in Aid (FCERM GiA) method.

The analysis has been completed using the Frontier's Toolkit, which indicates that in comparison to the FCERM GiA methodology losses (estimated at a present value of £25.8M), losses to Shrewsbury businesses of the order of £14.25M (an additional 55%) has been overlooked, and a more complete estimate is £40.5M loss on the basis of the Frontier's method.

There are also significant further additional losses which should be assessed to further demonstrate the full extent of losses that need to be managed in relation to the flooding burden on Shrewsbury businesses. Overall it is likely that losses are more than twice those estimated by prevailing methods.

This study suggests the approach used can make a real difference to Shrewsbury businesses because the method can provide the evidence base for demonstrating an improved benefit-cost ratio that can lead to increased funding for future flood alleviation works designed specifically to increase flood resilience to benefit Shrewsbury businesses and the local economy.

The study has demonstrated that additional losses need to be quantified in order to achieve a more appropriate risk management response to flooding in Shrewsbury and other English towns. Recommendations are presented for an appropriate way forward.

Foreword

Behind every business affected by flooding in Shrewsbury is a person — a family, a team, a story. Flooding doesn't just damage buildings; it disrupts lives, livelihoods, and the future of our community.

This Financial and Economic Losses Report, commissioned by Shropshire Council and the National Flood Forum, captures the real cost of repeated flood events — the visible damage and the hidden, lasting impacts.

By recognising the true scale of economic loss, we hope to drive stronger action, smarter investment, and better support for the people and businesses at the heart of Shrewsbury.

Tracey Garrett

Chief Executive Officer of National Flood Forum

Shropshire Council have been working with the National Flood Forum to support communities across the County through the establishment of Flood Action Groups for a number of years. These groups have focused on the impact of flooding on residential properties, and whilst it's essential that we work to protect peoples' homes the flooding of a business, particularly the small independent businesses that Shrewsbury is known for, can have an equally significant impact by affecting peoples' livelihoods.

In Shrewsbury the annual flooding from the River Severn has a huge effect on the town, and while some areas benefit from flood defences, the majority of the town remains unprotected, with previous studies failing to identify a cost beneficial scheme. This project and the work done by GeoSmart has provided the opportunity to review and update the methodology around how economic impacts can be calculated and will allow renewed discussions with risk management authorities around developing options for further defences for the town. It is hoped that this methodology can also be utilised as a case study to support funding bids where businesses are affected in other towns across the country.

John Bellis MCIWEM C.WEM

Drainage and Flood Risk Manager, Shropshire Council

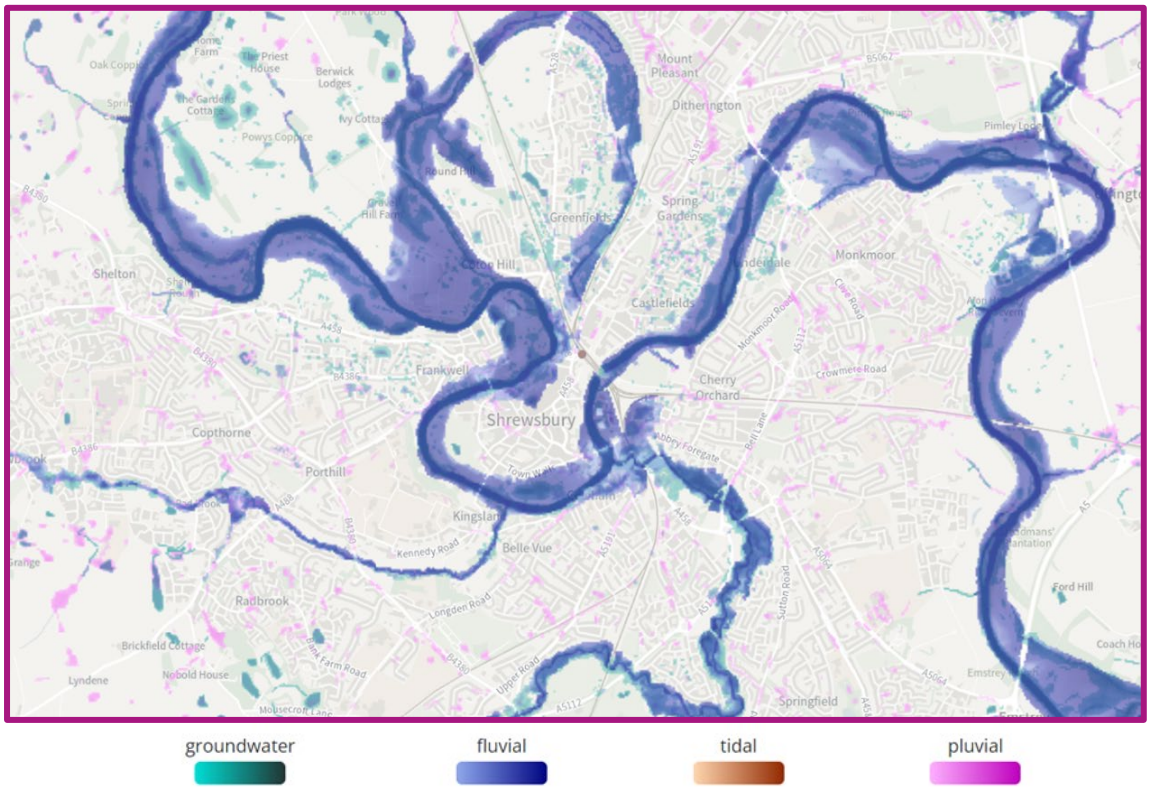
1 Introduction

Background

Shrewsbury is the largest town in the Shropshire Council unitary area, with a population of about 76,000. The town centre lies within a loop of the River Severn.

Shrewsbury suffers from river, surface water and groundwater flooding (Figure 1).

Figure 1. Flood risk from all sources in the Shrewsbury area



(FloodSmart Analytics, copyright GeoSmart Information Limited 2024)

Flood risk in Shrewsbury is predominately from the River Severn. The Initial Assessment published in 2021(IA) has confirmed that flooding in town is primarily caused by:

1. Overtopping of the River Severn during high events;
2. Overtopping of Severn tributaries due to high levels in the River Severn;
3. Flooding from drainage networks either due to:
    a. Inability of surface water to discharge due to high river levels;
    b. River water entering drainage networks through ineffective outfall valves.

Groundwater increases this risk further by exacerbating losses within the river flood risk areas where it leads to more frequent and longer duration events, posing a particular hazard to businesses in those areas. High river levels cause groundwater ingress to nearby properties even when river flooding does not occur directly by overtopping, and therefore occurs far more frequently than river flooding, as has been experienced in some of the case

studies presented in this report (e.g. The Salopian pub). There is also localised groundwater flooding risk outside these areas.

In addition to this there are localised areas of pluvial (surface water) flooding in many areas across the town. These are particularly problematic in built up areas such as the town centre and along roads, where drainage capacity can be exceeded during periods of high intensity rainfall.

Flood damage, business interruption and related costs are a significant burden on the local economy and the risk is increasing.

Local businesses suffer from significant losses including loss of trade, damage to premises and stock, loss of footfall, reduced access for staff, costs of flood response effort and recovery time to resume normal operations, perception of risk to level of service, mental health impact on staff and wider community and a host of other consequences.

The key objectives for this work are:

1. To quantify how much is missing from the IA, which has implications for Shrewsbury flood risk because IA consideration of mitigation measures will not be addressing this exposure, leaving businesses exposed and the local economy suffering.
2. To identify what additional benefit the Frontiers approach may offer, which could unlock additional funding or divert it from less beneficial projects.
3. To demonstrate how much difference this approach may offer and present recommendations for next steps.

Previous flood protection works installed in Shrewsbury only protect a small proportion of the total properties at risk, and some of these works will not meet future need following climate change.

This work is limited to an evaluation of the cost of flooding, but the methodology may support future cost benefit analysis when considering future protection schemes.

Established methods of economic analysis used by the Environment Agency and Defra do not adequately quantify the costs burden of flooding on business because the standard economic analysis uses the national economy perspective, which does not recognise a local loss if there is a compensating gain elsewhere. However, from the perspective of the local economy and enterprises there are significant losses that can lead to very real consequences, and there is a need for a different approach that recognises such costs appropriately.

Local businesses suffer direct and indirect financial losses and the local economy is impacted by flooding, incurring real harm to individual businesses and the local economy.

The Environment Agency commissioned Arup to undertake the IA at Shrewsbury. The IA is a pre-feasibility desktop study into flood risk and potential solutions which may be effective in mitigating these risks and their eligibility to attract Flood and Coastal Erosion Risk Management (FCERM) Grant in Aid (GiA) funding. The findings suggested insufficient return on investment within the GiA funding rules to enable Defra funding for further mitigation solutions, suggesting there would be a need for partnership funding to bridge the gap. This gap will probably widen further once costings are updated for significant inflation in the

sector in recent years, increasing the challenge of finding a mitigation strategy for Shrewsbury.

History of Flooding

Shrewsbury has a long history of flooding since its development in the 7th century. Increasing impacts and damage to the local economy led to a flood protection scheme for Frankwell which has been operational since 2004. The following summary by the Environment Agency[4] is still relevant today (although the influence of climate change has since been accelerating and needs to be a central consideration in any future flood risk assessment and mitigation):

"Over the years, development in Shrewsbury has encroached onto the floodplain, resulting in extensive areas at risk from flooding. There are approximately 400 residential and commercial properties at risk in Shrewsbury. In addition, transport links are severely disrupted during floods, thereby isolating the town centre.

The town has a long history of flooding problems with notable events occurring in 1795, 1941, 1946, 1947, 1960, 1964, 1965, 1968 and more recently in 1998 and 2000 (and subsequently in 2020 and 2022). The largest recorded flood was in 1795 when floodwater reached about two metres deep in the Frankwell area.

The largest flood in living memory was in 1946, although the November 2000 floods came within 230 mm of this depth.

Historically, a major flood has caused significant damage on average once every ten years, but time between floods can vary significantly. There has been a recent and dramatic increase in the number and severity of floods in Shrewsbury. Since 1998 there have been eleven flood events causing serious property flooding.

In the autumn of 2000, the worst flooding for over 50 years caused widespread damage along the length of the River Severn.

Shrewsbury was badly affected and the town was extensively flooded three times in the space of six weeks. As a result, the Environment Agency accelerated a feasibility study to investigate the provision of flood defences for the town.

Since the 1950's a number of flood alleviation options have been proposed for Shrewsbury.

These included increasing the size of the existing river channel, diversion channels, flood storage areas and flood walls and embankments in the town. In the early 1990's, a proposal for a scheme was rejected due to concerns over the visual impact of floodwalls in the town. However, innovative systems incorporating demountable barriers have provided a new alternative to overcome such problems."

The Frankwell flood alleviation scheme included a combination of fixed and demountable defences and followed significant political intervention at a time of heightened awareness of flood risk. However, it only offers protection for one part of town and leaves many homes and businesses unprotected, so it is widely recognised that significant flood risk from the

[4] Frankwell Flood Alleviation Scheme, an overview by the Environment Agency, 2004

River Severn still exists in Shrewsbury and there will be a need for further action, particularly in the light of climate change.

More details of recent flooding events are presented in Appendix A, including results of surveys of local businesses and case studies are presented in Appendix E illustrating the impact of flooding in recent years.

Shrewsbury has developed significantly over the last 20 years including infill housing and population increase within flood risk areas, but recent analysis has not found sufficient benefit-cost ratio to achieve Government Grant in Aid support for additional flood defence schemes. However, such analyses are based on a narrowly defined definition of what losses can be considered (in particular omitting most of the losses suffered by businesses) and this study sets out to identify a more complete estimate of losses which could help to support an improved cost-benefit analysis in future.

Objectives and scope of work

It is necessary to achieve an indication of the harm being suffered and expected in the future, both to help individual businesses to understand and manage their risk, and also for the local business community and wider stakeholders to be able to develop a suitable management strategy to mitigate these risks and to develop and implement appropriate risk management plans.

Financial losses suffered and likely to be suffered by local businesses operating within the Shrewsbury area of study are significant and it is helpful to quantify these losses in the aggregate in order to better consider what mitigation measures may be cost beneficial.

Current analysis methods used by the Environment Agency and Defra are focused on economic costs rather than financial, and on a national basis. This means that a local business in Shrewsbury may suffer losses from flooding but if goods they provide can be purchased elsewhere in the country this is not regarded within those methods as an economic loss and will therefore not contribute towards cost benefit analysis of potential mitigation measures such as flood defence proposals.

In order to better assess and manage flood risk to businesses a Shrewsbury Business Flood Action Group (SBFAG) has been established. Shropshire Council has successfully secured funding for this project to tackle some of the challenges posed by flooding to local businesses, and the initiative is a collaborative effort between Shropshire Council, the National Flood Forum and Shrewsbury BID, supported by funding from the West Mercia Local Resilience Forum.

The intention of this project is to quantify the financial losses suffered by businesses to provide an improved indication of damages and business losses so that future consideration of appropriate mitigation measures for Shrewsbury by the Environment Agency and local authority can consider the opportunity to factor in avoidance of such business losses as a benefit.

This initial work proposed here is a preliminary analysis based on available evidence only and is guided by the 'Light Touch' approaches advocated by the 'Frontier Toolkit'[5].

The scope of this work was limited to analysis of existing available data to:

- Assess the losses to Shrewsbury commercial businesses during River Severn flooding events including loss of business because of access disruption
- Compare the commercial damage based on financial losses to individual businesses as opposed to the economic losses to the nation as applied in the Defra/EA appraisal guidance where only national resource costs are eligible for the Flood and Coastal Erosion Risk Management Grant in Aid (FCERM GiA) funding by HM Treasury in line with the HM Treasury Green Book guidance on the financing of Government infrastructure costs (see Appendix A).
- Supplement the available data by consulting the local business community through a questionnaire survey and some detailed case studies for selected businesses to further elaborate the nature of the problems they face (see Appendix E).

The analysis provides a preliminary estimate of the cost of flooding to Shrewsbury businesses on the basis of available data.

The study is limited to considering flooding of the River Severn in order to ensure consistency with previous work for the Environment Agency and therefore does not consider groundwater or surface water flooding.

[5] Frontier's Toolkit, developed under the Joint Defra/EA FCERM R&D programme - project FD2662 'Flood and coastal erosion risk management and the local economy' 2014.

2 Assessing the cost of flooding to businesses

The cost of flooding includes both immediate tangible losses suffered by businesses due to flood damage, for example to premises, stock and operating equipment, and it also includes consequential losses such as those resulting from business interruption and loss of trade.

This study is therefore considering these two categories of cost to business:

1 Damage to premises, stock and operating equipment. These are estimated using standard published national depth/damage databases that draw on historical flooding events and evidence for actual damage to property.

2 Losses resulting from business operations during flood periods and their aftermath and those relating to business interruption. These include losses of revenue when access to town and footfall is reduced but would otherwise have been expected if it were not for the effects of the flooding and how the events are managed and communicated by relevant parties such as local authorities and the Environment Agency. Losses are estimated by reference to Gross Value Added (GVA) foregone and evidence for the scale and duration of impacts.

Studies of the cost of flooding are widely undertaken in cost-benefit analysis in the UK to help demonstrate the value of damage avoided, for example, as the business case for considering flood alleviation schemes. Government and Partnership funding can be obtained when a business case is considered to offer significant gains beyond the cost of the protection measures being considered. For such reasons detailed evidence for benefit-cost ratios for specific schemes are undertaken at various stages of consideration.

This current project is not intended to provide a cost-benefit analysis for any specific scheme, but instead to derive a preliminary estimate to illustrate the scale of potential costs related to business losses that could be considered in relation to other costs already estimated in the prevailing Government approach when future schemes are under consideration.

The work undertaken in this study is described in detail in Appendices B, C and E, and a summary of findings is presented in the report (Section 6) along with conclusions and recommendations (Sections 7 and 8).

3 The fundamentals of Project appraisal for Flood Alleviation schemes in England

In Shrewsbury there has already been an Initial Assessment (IA) focused on outline flood alleviation scheme proposals[6]. This has used the standard Flood and Coastal Erosion Risk Management Grant in Aid (FCERM GiA) Partnership Funding (PF) calculator.

Based on the proposed contribution to outcome measures and the costs of the project, the PF calculator produces a raw PF score. This gives a percentage score of how likely (eligible) FCERM GiA is to fund a particular project or option. Similarly, the adjusted PF score shows the extent to which the available FCERM GiA and any proposed financial contributions from third parties are required to fund a particular project or option.

The raw PF score is an indicator of the efficiency of FCERM GiA investment. A raw PF score below 100% shows that there is insufficient eligible FCERM GiA available from the qualifying benefits to fully fund the project. This may be because project costs are relatively high or because qualifying benefits are relatively low, or a combination of both. In these circumstances, financial contributions (based on other local or national benefits and outcomes) or cost efficiencies can increase the PF score to, or above, 100%.

Some possible schemes to provide additional flood alleviation could demonstrate increased viability if the additional (damages and losses avoided) outcomes assessed in this study were factored in. This is not currently done, but the analysis presented in this report illustrates there may be scope to do so in the future.

The prevailing methods of economic analysis follow a strict protocol for justification of flood alleviation expenditure in England.

Business Losses however are mostly NOT included as from a national standpoint most of the losses incurred during flooding are likely to be made up by deferring purchases or services to a post flood date or transferring these purchases and services to a non-flooded area.

This means that business losses to premises operating in Shrewsbury were mostly not included in the appraisal process undertaken previously for the Environment Agency by Arup consultants.

In this study damage is estimated not only from an economic or national UK plc perspective but also from a financial (or local) perspective with additionality of benefits accruing to the local and wider regional community. For example, loss of business suffered from the properties in the four flood zones (Coton Hill, Coleham, St Julians and Smithfield) within Shrewsbury would not be counted in an economic appraisal, as this lost business may either be transferred to other companies elsewhere in UK or deferred until the site becomes flood free. These are however counted along with 'financial damages' as 'financial losses' in this study (more closely reflecting insurance losses).

[6] Initial Assessment Shrewsbury final version 26 May 2021. Arup and Partners report to Environment Agency

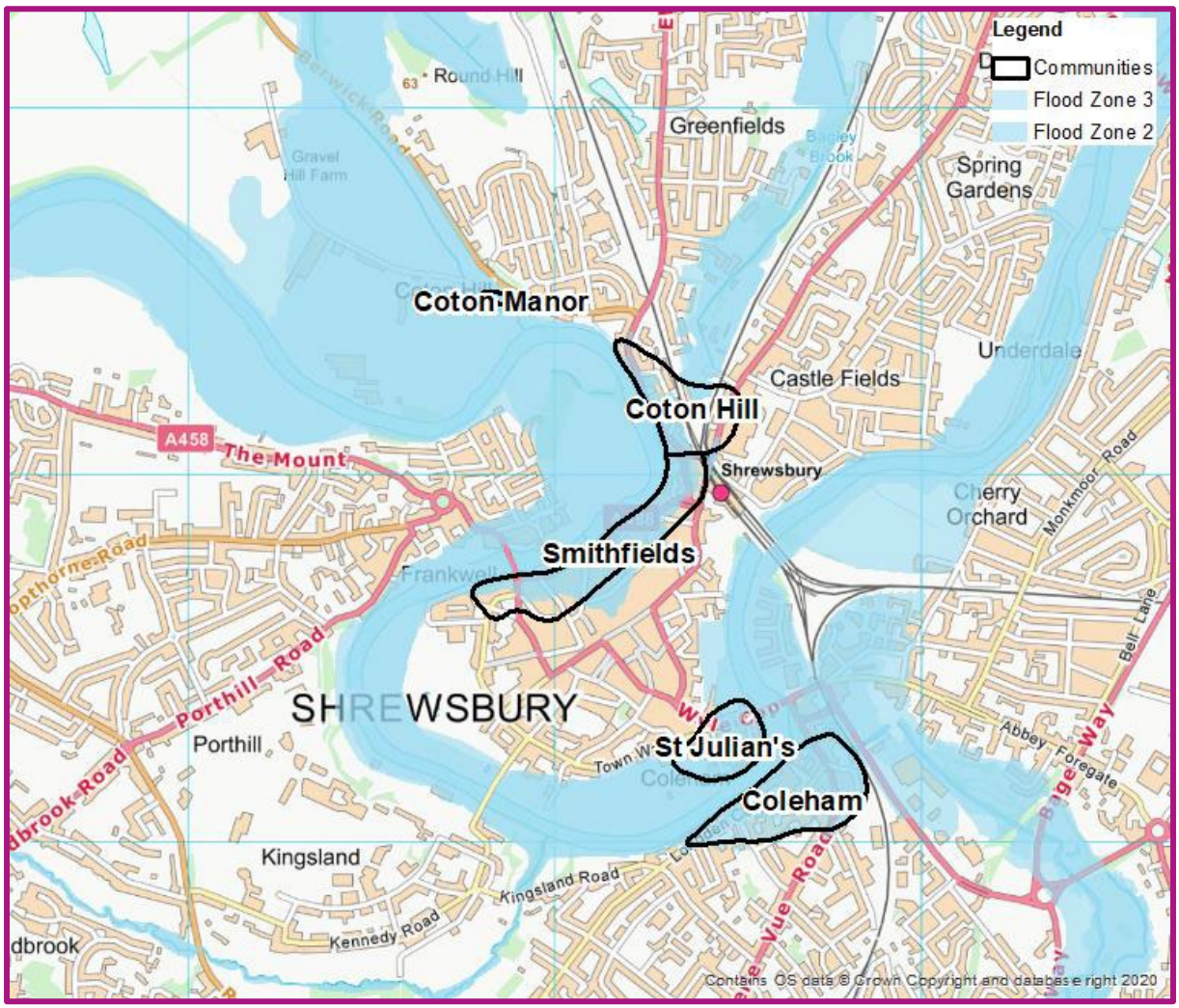
Financial versus Economic Damages

To summarise, the difference between financial and economic damage:

- Economic Damage is a resource cost to the nation and does not include transfer payments from consumer to the exchequer (VAT). It also does not include betterment, i.e. a damaged item of equipment and furniture is assumed to be part way through its life cycle and only the residual damage is included in the damage calculations. Only the economic damage avoided (by a scheme option) is included in FCERM GiA benefit calculations
- Financial damage is an actual cost to the local economy incurred by the consumer or business. These include betterment and are closer to insurance costs.

By local economy we mean all those economic activities which take place in a locally defined geographical area such as the area defined by a local authority boundary, a group of local authority areas or a sub-region or even a much smaller area such as the area protected by a flood risk management scheme. In this project Shrewsbury town area delineated by the Initial Assessment flood zones forms the boundary for damage and business losses, as shown in Figure 2 below.

Figure 2. Five communities in Shrewsbury that suffer significant flood losses, shown along with Environment Agency flood zones (undefended)



Five communities were considered the highest priority to both the Environment Agency and Lead Local Flood Authority (LLFA) and were the subject of the Arup Initial Assessment, as a result of:

- Frequency and magnitude of historical flooding, backed up by Environment Agency and hydrological modelling;
- Number of properties in the community;
- Areas worst affected by the 2020 floods.

The communities selected for supplementary analysis in this study were; Coton Hill (not Coton Manor because there are no listed businesses there), Smithfield, Coleham, and St Julian's.

Financial damage as estimated for Defra 'Who benefits' project[7] can be as much as 52% greater than economic damage for Non-Residential (commercial) properties.

[7] HR Wallingford Ltd. in association with Flood Hazard Research Centre and JB Chatterton & Associates Who Benefits from Flood Management Policies? R&D Final Report FD2606, 2008

Business Losses using the Frontiers Toolkit

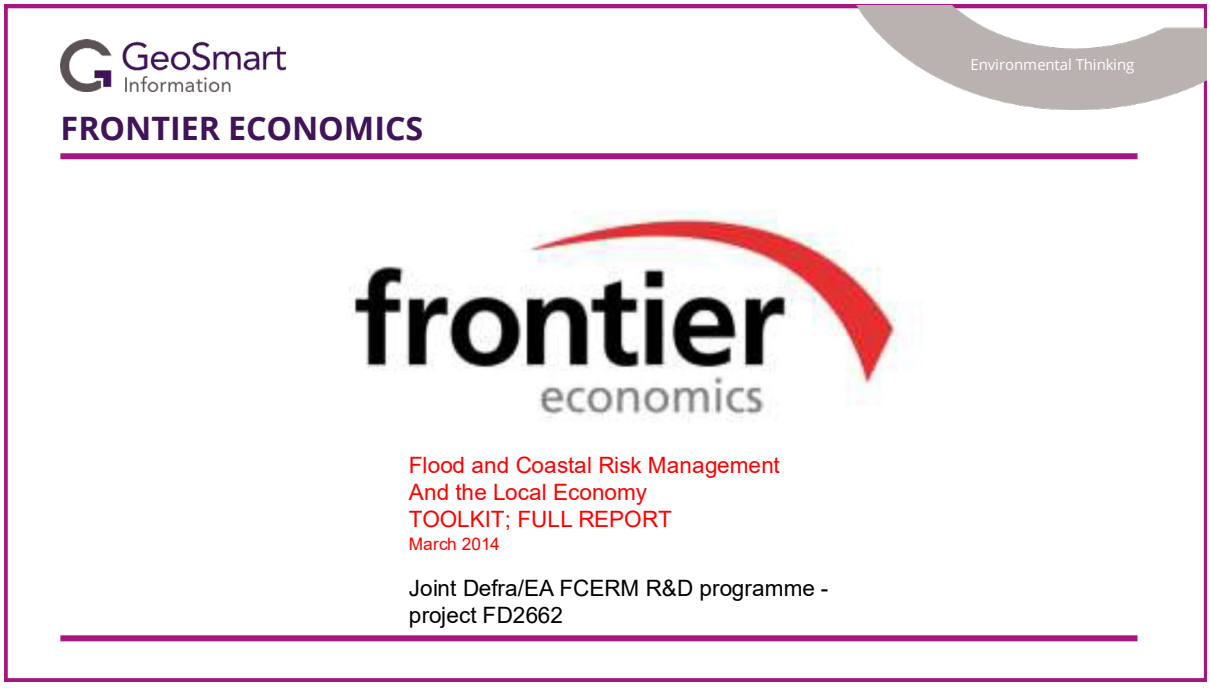
In the floods of 2000 across England, business interruption costs comprised 31% of the total direct commercial damage claims made to insurance companies. In the floods of 2007[8], business interruption costs were estimated to be 27.6% of total direct business damage. However, in order to recognise such losses when considering how much a flood alleviation scheme would avoid them, it has proved hard to obtain sufficient evidence using traditional methods.

For this reason, as part of the introduction of Partnership funding the Environment Agency and Defra commissioned Frontiers Economics to produce a tool kit for evaluating Business Losses (Figure 3).

In their preface to the publication, Defra stated:

> *"We commissioned this work as a step towards making the existing economic appraisal system for FCERM projects more useful for local partners such as Local Authorities, Internal Drainage Boards, Local Enterprise Partnerships, business groups and other beneficiaries of flood and coastal management and land drainage."*

Figure 3 The Frontiers Toolkit



The principle of the Frontier's method is to evaluate business losses to commercial properties to garner evidence for Local Funding to supplement FCERM GiA funding.

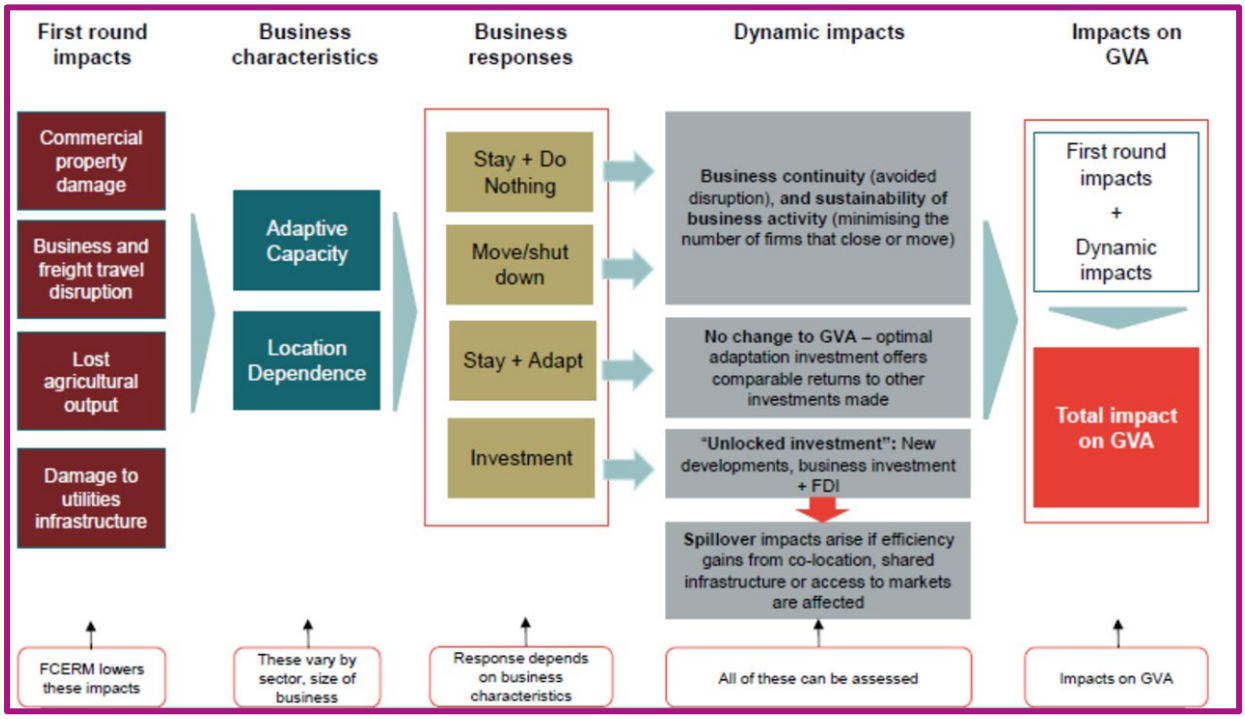
The Frontiers Toolkit is used in this study as intended for local bodies (principally Local Authorities) who are considering, or would like to encourage others to consider, contributing partnership or other funding for FCERM. This is in recognition of the local benefits of FCERM and to supplement funding which may be available through FCERM Grant in Aid.

[8] John Chatterton, Christophe Viavattene, Joe Morris, Edmund Penning-Rowsell, Sue Tapsell The costs of the summer 2007 floods in England Project: SC070039/R1 2010

The relevant definition of 'the local economy' is businesses and their employees located in the geographical area that is of interest to the local practitioner; in this study that is all properties within the Shrewsbury Initial Assessment focus area. The metric of impact considered here is a monetary measure of the value added by businesses to the local economy, defined as Gross Value Added (GVA). GVA measures, therefore, the contribution to the economy of each individual producer, industry or sector.

The Frontiers Toolkit model is summarised in Figure 4.

Figure 4 The Frontiers Toolkit Model



From FRONTIERS research the following are legitimate Local losses/benefits:

1. Temporary loss of GVA from employment whilst a business is flooded and then is repaired
2. Temporary loss of GVA from employment while access to businesses is disrupted
3. Permanent loss of GVA for properties unable to stay and adapt following flooding
4. Permanent employment opportunities by unlocking land for development, following the introduction of a flood mitigation scheme

Losses 1 and 2 are included in this analysis. Additional investigations would be required to quantify 3 and 4.

In summary, the differences between financial and economic damage is critical, but FCERM GIA assessment methods largely ignore local business losses and potential financial damage.

There is therefore a need to recognise business losses to enable a more complete assessment, and application to cost-benefit analysis, and use of the MCM Financial damage and the Frontier Toolkit methodology (Appendix B) to provide an appropriate method to

estimate damage and losses respectively. The detailed analysis of these additional damages and losses is in Appendix D.

4 The cost of flooding to Shrewsbury

The Shrewsbury Context in relation to business losses

Shrewsbury has over 750 businesses within its town centre, with more than 5,000 businesses having their registered office in the Shrewsbury Town Council area.

Some further indications of the scale of the local business community in terms of number of enterprises and operating premises:

- Commercial Units: A 2023 audit found 764 commercial business premises within the Shrewsbury survey area.
- Town Centre Businesses: The Shrewsbury Business Improvement District (BID) represents over 500 businesses in the town centre.
- Business Proprietors/Sole Traders: There are approximately 1,500 business proprietors/sole traders based in Shrewsbury and independent retailers outnumber big chains by almost a half[9].

422 businesses in Shrewsbury were given grants to offset losses related to the February 2020 flooding events. This provides an indication of the scale of the problem to local firms in terms of loss of trade.

Shrewsbury businesses are disproportionately hit, for reasons including:

1. The town centre has limited access points due to location on a loop of the River Severn, and these are subject to flooding that effectively cuts off access to the town centre.
2. Shrewsbury has a higher proportion of independent shops than most towns[10] (for example Wyle Cop, one of the high flood risk streets has the UK's longest uninterrupted stretch of independent shops) and independent shops are less able to recover from flooding than regional and national chains[11].
3. The independent shops are more likely than larger enterprises to fail as businesses when flooding hits, particularly due to the longer time taken to recover and resume trading, with surveys in the insurance sector[12] highlighting the consequences of flooding on SMEs being more burdensome, with the following statistics:
    a. 40% of small businesses will close for good after significant flooding

[9] https://www.shropshirestar.com/entertainment/2020/08/09/the-futures-bright-helping-to-boost-shops-after-lockdown/

[10] https://www.visitshropshire.co.uk/get-shopping-in-shropshire/

[11] https://www.sciencedirect.com/science/article/abs/pii/S2212420922005350#:~:text=Small%20businesses%2C%20which%20contribute%20significantly,and%20skill%20deficiencies%20%5B9%5D.

[12] https://www.marshcommercial.co.uk/articles/flood-risk-facts-every-british-business-should-know.html#:~:text=1.,five%20days%20following%20a%20disaster.

b. 52% of small businesses reporting it would take at least three months to recover, and

c. 90% of smaller companies failing within a year unless they can resume operations within 5 days, but the average flooding impact is 50 lost working days and a direct damage cost of £80,000.

As a medieval town built on the river, many of the commercial premises lie within flood risk areas, and it is challenging to protect such riverside locations without impacting negatively on the river amenity value. Some of the older properties within areas at particular risk of flooding have become a significant success story for Shrewsbury independent firms rather than bigger corporate entities, and future flood protection will need to recognise these issues affecting the business community if a more optimum risk management approach is to be realised.

A report by Shropshire Council[13] Overview Committee following the 2020 floods adds further context relevant to this report, particularly business support and transport disruption to public services. Business support is relevant here as The Business Support and Investment Team within Economic Growth supported businesses throughout Shropshire affected by the floods.

Following the 2020 flooding in Shrewsbury associated with Storm Dennis the UK government provided a Business Recovery Grant which was administered by Shropshire Council. A maximum grant amount of £2,500 was available to eligible businesses to contribute towards direct and indirect costs (predominately loss of sales) incurred over the period. There were 556 unique applications by Shropshire-based businesses, with 79% being based in Shrewsbury (422). 59% of Shrewsbury's applications were concentrated within the river loop of the town centre. 40 were directly affected by the flooding citing physical damage and the rest (209) had their trade affected by the road closures and limited physical access into the area.

The average claim was £2,053. However, it is worth noting that 333 or 60% of the applications (throughout Shropshire) were for the maximum amount of £2,500 with many stating losses well in excess of the amount they were able to claim.

Additional financial support was provided in May 2020, with over £2m of Growth Funding awarded by the Marches Local Enterprise Partnership (LEP) to Shropshire Council and the other Local Authorities

Furthermore,[14] a Cabinet paper in September 2020 summarised the effect of flooding on Gross Value Added (GVA). GVA is a measure of the economic output and value generated by a region, industry, or sector. In the context of the River Severn Partnership and Shropshire Flood Prevention, some additional flood alleviation measures were considered, and the document highlights significant GVA benefits that could be obtained in the event of a more comprehensive flood protection scheme being developed to benefit Shrewsbury.

[13] 2020 Floods - Communities Overview Committee, Shropshire Council, 8 December 2020

[14] River Severn Partnership - Shropshire Flood Prevention, report to Cabinet office, 27th September, 2020

The effect of duration on business losses

Research[15] shows that duration of business interruption can often extend to many weeks, and smaller businesses are likely to be impacted for longer than the larger corporates. They also typically have less financial resources and ability to survive periods of business closure.

The evidence therefore shows that smaller businesses typical of Shrewsbury are disproportionately vulnerable and threatened by flooding events.

The questionnaire survey conducted for this study suggested much shorter outages than would be expected from previous studies. Of the 22 properties (out of 36) saying they have not had flooding in their property the mean loss of trade through limitation of access was around 5 days, which was only marginally less than the mean outage for flooded properties (7 days). It is likely that the deeper the flooding (and therefore the rarer the flood) the greater the potential outage. Furthermore, the most serious business outages will have caused the maximum number of permanent business closures and such businesses are consequently not able to participate in surveys. A more detailed study will be required to improve the evidence base on this topic for Shrewsbury.

The recommendation by Frontier is to use earnings per day per employer which for Shropshire (Full time) is a median value of £105/day for 119,000 jobs[16] (Annual Survey of Hours and Earnings, Office of National Statistics). Ideally, the earnings should be estimated separately for each Standard Industrial Classifications (SIC) but this was not done for this limited study. Most of the properties in the Arup analysis of flood damage are either retail, services or office.

The number of employees in each commercial enterprise in the maximum flood zone was derived from the median value of all properties (9 employees) from the 36 Questionnaire surveys.

Flood impact areas and work done to date on damage and economic analysis

The Arup Initial Assessment (2020) formed the basis for GeoSmart's analysis in this study, which was therefore devised as a supplementary study.

The Arup IA was based on hydraulic modelling work undertaken for the Environment Agency in 2020[17].

Some inconsistencies and discrepancies were identified within the data provided, but these are not considered to affect the conclusions in this preliminary report significantly.

The following summarises the Arup IA key findings in relation to the River Severn:

> *Overtopping of the River Severn is anticipated to occur in all of the five considered communities even at low return period events, as shown by the fluvial modelling. Once water*

[15] https://www.marshcommercial.co.uk/articles/flood-risk-facts-every-british-business-should-know.html

16 Office of National Statistics - Table 8.1a Weekly pay - Gross (£) - For all employee jobs: United Kingdom, 2024

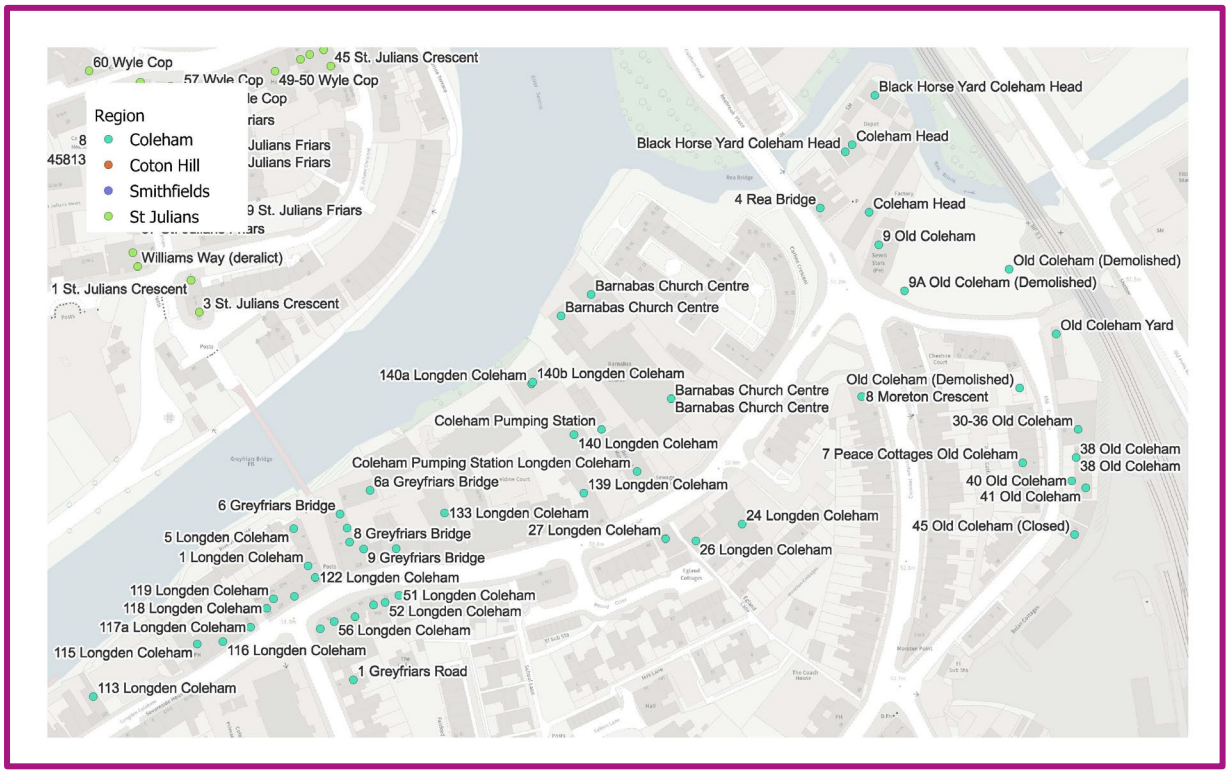
[17] Environment Agency modelling 2020 Interim 1D-2D River Severn model (Domain 1 – Shrewsbury)

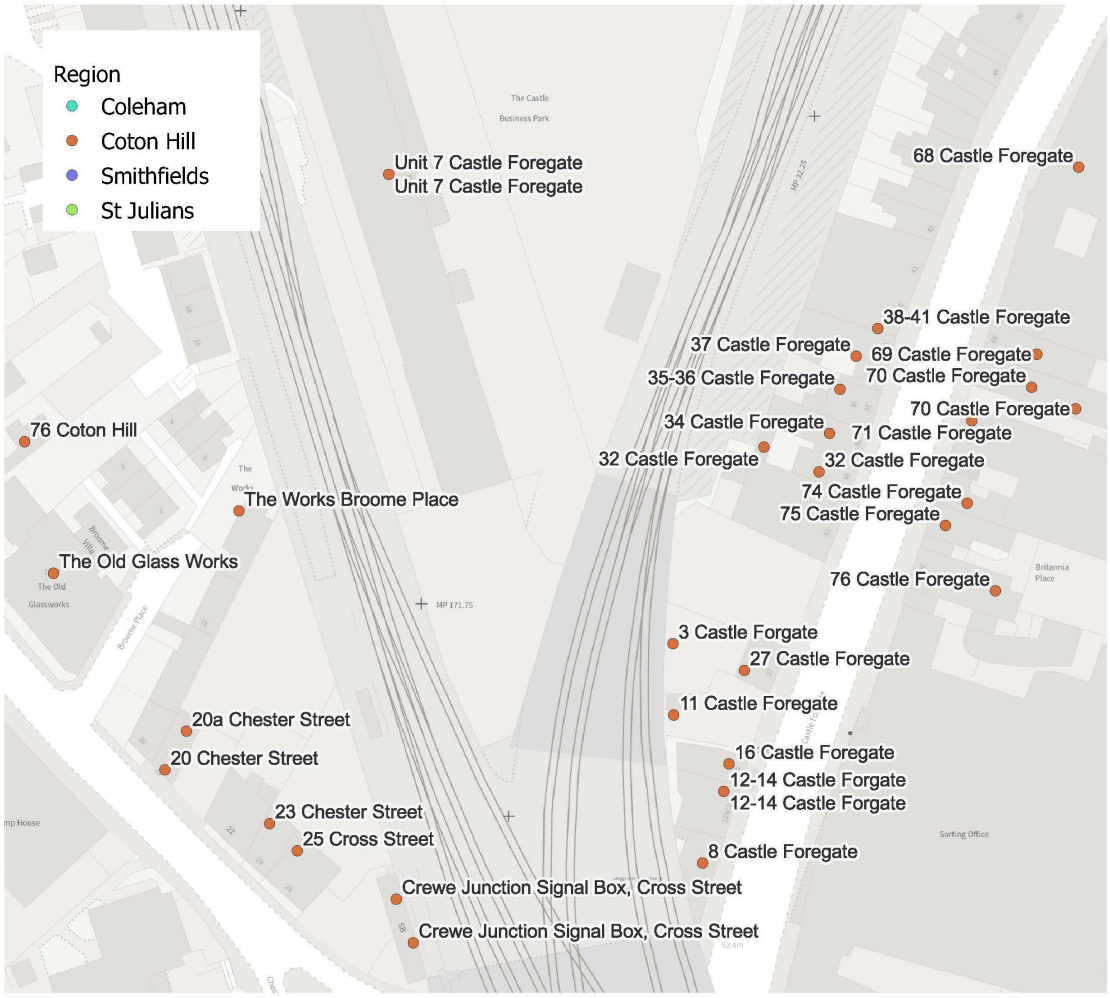
levels rise in the Severn, they are also known to stay high for a significant duration, therefore increasing the damage and disruption caused

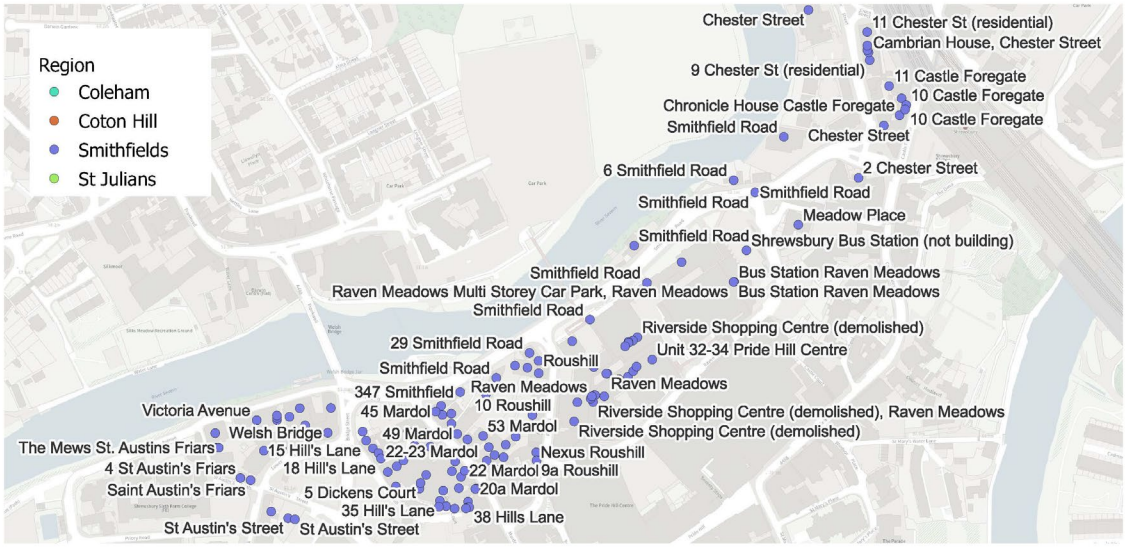
The Initial Assessment identified 4 principal flood zones close to the town centre which represented the main non-residential areas with properties at risk from overtopping of the River Severn, so this supplementary study concentrates on the commercial properties within these 4 principal flood zones (Figure 5 a to d).

- Coleham
- Coton Hill
- St Julian's
- Smithfield

Figure 5 a to d. The locations of business premises subject to flooding within each of the flood zone areas




Region
Coleham
Coton Hill
Smithfields
St Julians
Unit 7 Castle Foregate
Unit 7 Castle Foregate
68 Castle Foregate
38-41 Castle Foregate
37 Castle Foregate
69 Castle Foregate
35-36 Castle Foregate
70 Castle Foregate
70 Castle Foregate
34 Castle Foregate
71 Castle Foregate
32 Castle Foregate
32 Castle Foregate
74 Castle Foregate
75 Castle Foregate
76 Coton Hill
The Works Broome Place
The Old Glass Works
76 Castle Foregate
3 Castle Forgate
27 Castle Foregate
11 Castle Foregate
20a Chester Street
20 Chester Street
16 Castle Foregate
12-14 Castle Forgate
12-14 Castle Forgate
23 Chester Street
25 Cross Street
8 Castle Foregate
Crewe Junction Signal Box, Cross Street
Crewe Junction Signal Box, Cross Street


Region
Coleham
Coton Hill
Smithfields
St Julians
Chester Street
11 Chester St (residential)
Cambrian House, Chester Street
9 Chester St (residential)
11 Castle Foregate
10 Castle Foregate
Chronicle House Castle Foregate
10 Castle Foregate
Smithfield Road
Chester Street
6 Smithfield Road
2 Chester Street
Smithfield Road
Smithfield Road
Meadow Place
Smithfield Road
Shrewsbury Bus Station (not building)
Smithfield Road
Bus Station Raven Meadows
Raven Meadows Multi Storey Car Park, Raven Meadows
Bus Station Raven Meadows
Smithfield Road
Riverside Shopping Centre (demolished)
29 Smithfield Road
Unit 32-34 Pride Hill Centre
Roushill
Smithfield Road
347 Smithfield
Raven Meadows
Raven Meadows
Victoria Avenue
45 Mardol
10 Roushill
Riverside Shopping Centre (demolished), Raven Meadows
Welsh Bridge
49 Mardol
53 Mardol
Riverside Shopping Centre (demolished)
The Mews St. Austins Friars
15 Hill's Lane
22-23 Mardol
Nexus Roushill
4 St Austin's Friars
18 Hill's Lane
22 Mardol
9a Roushill
Saint Austin's Friars
5 Dickens Court
20a Mardol
35 Hill's Lane
38 Hills Lane
St Austin's Street
St Austin's Street

The report uses financial property damage data[18] from Middlesex University's Flood Hazard Research Centre (www.mcm-online.co.uk) and applies the 2014 Frontiers Toolkit to measure the extent of Business loss.

There is no consideration during this preliminary analysis of the potential for post flood mitigation developments which is also part of the Frontier's Toolkit. This would involve consideration of future strategic planning initiatives following engagement with relevant stakeholders.

The Frontier's Toolkit relies on the loss of GVA as a result of closure of businesses or due to limitations in access to their premises due to River Severn flooding. No costs associated with groundwater or surface water flooding have been included.

The current report concentrates on the uplift of damage and losses using financial damage datasets and the Frontier's Toolkit for commercial properties located within the 4 sub areas above. The impact of flooding on other premises in Shrewsbury is not included.

[18] Flood and Coastal Erosion Risk Management: A Manual for Economic Appraisal, 2013 Flood Hazard Research Centre.

Questionnaire

A detailed questionnaire survey was undertaken to help engagement with local businesses and acquire additional information to help shed light on the impact of flooding on the businesses of Shrewsbury. We are grateful to Stephanie Mansell-Jones of Shrewsbury BID for running this survey online. Appendix C analyses some of the more important findings from the questionnaire from completion by 36 local businesses

A number of businesses volunteered to provide more in-depth information through site visits and additional business data, and examples of these are presented in Appendix E as case studies.

The case studies further illustrate some of the problems faced by businesses in Shrewsbury and how they have sought to increase their resilience and incorporate active and passive flood protection in their premises and adopt flood action plans to help them survive flooding events.

Over 80% of the 36 questionnaire respondents have considered relocating to avoid potential future flooding and 58% have worried they would have to close their business due to the impacts of direct or indirect flooding.

The mean period of businesses out of operation due to preparing for flooding, dealing with the flood and clean up afterwards is 7 days, though from experience more 'catastrophic' flooding would take longer to recover. However, the length of time trade was disrupted for properties whether flooded or access affected is 5.9 days, with a maximum of 21 days.

Over the last 5 years, the estimate of financial losses respondents have suffered due to loss of trade / access limitations / reputational damage to the town / lowered footfall is a total of £1,574,000 with a mean of £43,722 or around £315,000 per year with a maximum loss experienced by one respondent of £400,000 in a year.

In conclusion, it can be seen that some businesses suffer significant damage and losses due to flooding of their premises. In addition there are very many businesses that suffer some losses due to frequent disruption to trade related to actual flooding events and also communication issues arising from announcements that visitors should avoid Shrewsbury due to flooding, even when such events would not stop businesses and visitors continuing as normal, or subject only to minor limitations in their access for shopping, work or other activities.

Local car parks and roads close significantly longer than they are actually flooded, and local flood responses may disrupt the economic life of the town significantly even when flooding does not actually occur at the levels forecast, or for significantly longer. These risk management responses therefore lead to loss of trade and success for the local economy, often diverting shoppers to other towns or online.

5 Analysis and Data Uncertainties

Full details of the analysis undertaken in this study are presented in the appendices. A summary of findings is presented in Section 6.

Data Uncertainties and Limitations of the Analysis

This assessment of both potential financial damage and business losses has several significant uncertainties that need to be recognised. The study has relied on existing information and verification of some data has not been possible.

Some of the main data limitations and uncertainties encountered in the study were:

- The Arup dataset of property addresses was not all successfully cross referenced to the properties identified in the business survey.
- The employment numbers for each property was based on the median of the 36 enterprises (7 employees) completing the questionnaire, which may not be representative for other enterprises not in the questionnaire sample.
- Loss of access to those businesses located in properties that were not flooded but suffered access limitations was not verified by this study. It was useful to refer to the 209 properties identified in the Shropshire oversight committee report of 2020 but representativeness is not confirmed.
- The Arup property records (from the Environment Agency NRD – National Receptor Data set) were not ground truthed in any detail so there was confusion as to the properties in the flood plain that were definitely or probably at ground level (dg/pg) and those probably at a raised level i.e. on the first flood (ru) recorded upper or (pu) probably upper.
- The outages averaged from the 36 questionnaire responses were from experience low and preferentially relate to experience of limited flood depths. The Devonomics research quoted above suggests outage figures of between 10 and 20 days. These were used as upper and lower bands for flooded properties in the IA model.
- Access disruption at about 5 days was supported by the available evidence but longer disruption may be likely.
- The Arup model was based on 4 return periods (5,000-100-50-10 years) and the threshold of flooding (where damage are zero) was uncertain. The lack of more frequent return periods can distort the Annual Average Damage (AAD) and this introduces additional uncertainty to the analysis.
- Although outage length was used equally for all return period floods, the more extreme floods from experience would have considerably longer outages but these longer outages are offset by their modest proportion of AAD under the loss probability curve.

In addition to the quantitative analysis presented above, there are a number of other categories of losses that have not been quantified in this report but that need to be recognised. These include:

- Wider impacts of flooding on business prospects. The evidence presented here demonstrates that flooding has a significant negative impact on business revenues and hence profits. This in turn will significantly affect the prospects of a local business and their ability to compete with other enterprises elsewhere in the country and overseas, impacting on the local economy and prospects for Shrewsbury as a whole.
- Mental health. Recent studies[19] have shown there is a very significant impact of flooding on mental health. Furthermore, that there is an adverse impact on the mental health among those whose lives are disrupted by flooding as well as those whose homes are flooded.
- Impact on property values. The effect of flooding on property and business values is complex and the subject of ongoing research. However, it is clear that property values and rental incomes are reduced during periods of flooding and this can have a blighting effect on property values in Shrewsbury long term. However, research in Carlisle follow in devastating floods of 2005 when 1,800 properties were flooded to often significant depths showed that any downturn in property prices was a temporary blip and other factors drive price rises and slumps
- Increase in price for insurance cover / unavailability of insurance
- Loss of car park revenues and other town centre revenues
- Losses due to infrastructure damage and additional maintenance
- Losses due to businesses moving away from Shrewsbury
- Consequential losses due to loss of employment in the town
- Permanent loss of GVA for businesses unable to stay and adapt following flooding
- Permanent employment opportunities by unlocking land for development, following the introduction of a flood mitigation scheme
- Lack of the financial gains that would be obtained if a flood defence scheme was installed

[19] https://assets.publishing.service.gov.uk/media/5e6bb75fd3bf7f2695546ba8/Summary_of_findings_NSFH_January_2020_Final_for_DsPH__3_.pdf#:~:text=Many%20people%20experience%20persistent%20flood%2Drelated%20damage%20to,is%20associated%20with%20worse%20mental%20health%20outcomes.&text=Two%20years%20after%20floods%2C%20people%20whose%20homes,those%20who%20did%20have%20such%20insurance%20(5).

6 Summary of Findings

Results from the Frontier's Toolkit Analysis

Analysis of the Arup Initial Assessment database and findings, considered alongside the Frontier's Toolkit analysis conducted in this study (Appendix D), showed the following results:

Summary of Premises Damage and Business Losses		
Damage or Loss Category	Present Value of Damage or Loss Estimated £Million	Notes on calculation
Economic losses recognised by FCERM GiA (updated from Arup's Initial Assessment). Total	25.8	A
Total property damage estimated by GeoSmart using MCM Financial Data	30.7	B
Financial damage uplift estimated by GeoSmart	4.9	B - A
Frontier business losses from flooded premises estimated by GeoSmart	3.0	C
Frontier business losses due to access restrictions estimated by GeoSmart	2.5	D
Additionality factor (70%) on business losses related to local economic connectivity estimated by GeoSmart	3.9	(C+D)*0.7 = E
Total	40.1	B+C+D+E= F
Uplift (of £14.3Million) from FCERM GiA Total	55%	(F-A)/A*100 (%)

Note: Subject to rounding errors

It can be seen that using the Flood Hazard Research Centre Multi-Coloured Manual financial datasets (2024) and applying the basic Frontiers Toolkit results in additional damage to that recognised in the IA of about 55%. This demonstrates that significantly more losses are incurred by the businesses identified than has been recognised using the FCERM GiA methodology.

There are also a number of other losses that add significantly to this figure but have not been quantified or included in this estimate of uplift.

The analysis has demonstrated additional losses that may be avoided in a future flood alleviation scheme and help to demonstrate that the business case for such a scheme will be significantly stronger than appears through the standard FCERM GiA Partnership Funding calculations.

Notes to the main assumptions:

Present value of damage and/or losses is the annual average damage or loss over a 50-year time period using current HM Treasury discount rates.

Integration of all years is undertaken on the same basis as the FCERM GiA FP calculator.

Only Business premises identified by Arup within the flood communities listed are assessed. There may be more business premises for which losses have not been estimated here. Equally the assessment includes no residential properties.

The Arup commercial damage figures were updated to 2024 data in this study to enable comparison with 2024 financial data using Frontiers.

Frontiers' Toolkit business losses are based on GVA using standard Shropshire data from the Office of National Statistics 2024.

205 business premises were included in the analysis. There are many more businesses that will have suffered and will in the future suffer from losses when Shrewsbury floods.

Additionality has used 1.7 factor as the effect on regional repercussions. It is a multiplier applied to business annual loss to estimate connectivity with local trade typical of an English county town.

Business loss "access only" annual average losses means there is a business loss due to access restrictions for trade such as that encountered during road closures and surface inundation preventing or limiting access by foot or by car etc.

Other Losses not Included Within the Frontier's Results

The Frontier's Toolkit analysis includes specific losses that enable comparison on a like for like basis with the prevailing FCERM GiA analysis for Shrewsbury.

There are however a number of other losses to businesses locally that are not included in this analysis but which contribute to the total losses suffered by local businesses.

The main categories of other losses that need to be recognised in order to complete the overall picture are summarised below.

Future Flooding Not Included in IA

River Flooding from the River Severn

River flooding from the River Severn was assessed according to recent modelling for the Environment Agency. No other flooding was included in the IA and therefore no other flooding was included in this assessment (in order to restrict this report to a 'like for like' comparison). There is currently further modelling and analysis being undertaken on behalf of the Environment Agency which it is envisaged will provide revised flood predictions next year and it will be appropriate to consider this new data in any future work.

Non-Stationarity

Hydrological estimates usually assume extreme flood events in the past are 'stationary'. This is where we assume past flood events can represent future flood events. In reality there have been and continue to be many changes in the catchment that increase flood risk, including increase in drainage and changes in land use that encourage more rapid and increased surface runoff. This leads to increased flood risk over time.

There are also other changes that may decrease flood risk and non-stationarity effects need further review to confirm the extent of these on changing flood risk to businesses in Shrewsbury.

Impact of Changing Climate on River Severn

The IA assumed the future effect of increased runoff to the River Severn in accordance with guidance from the Environment Agency in 2016 for peak river flow allowances. Peak river flow allowances show the anticipated changes to peak flow after climate change.

For the Severn catchment upstream of Shrewsbury, the peak allowance recommended provided for 25% increase[20] for the 1% AEP plus climate change scenario, adopting the 'Central' allowance. This was included in the Arup IA. However, the latest guidance from the Environment Agency (updated on 17 May 2022) is to use 33%[21] for the Central allowance and this latest guidance from the Environment Agency also suggests that for some cases such as essential infrastructure the 'Higher Central' allowance for climate change should be used instead. In this case this would entail modelling the impact of River Severn flows at 43% increase to peak flow. Furthermore, it is also notable that the Upper allowance for climate change recommended for predicting flooding impacts is significantly higher at 68%. Each of these projections for precipitation would lead to significantly more businesses impacted and additional losses compared to those estimated in this report.

There has also been recent research[22] suggesting that risk of future flooding may increase faster than the Environment Agency guidance suggests, and the selection of appropriate future scenarios needs further review.

[20] Environment Agency guidance 2016, River Severn Basin – Central Allowance for Epoch 3 ('2080's')

[21] https://environment.data.gov.uk/hydrology/climate-change-allowances/river-flow?mgmtcatid=3076

[22] https://www.metoffice.gov.uk/about-us/news-and-media/media-centre/weather-and-climate-news/2023/new-research-shows-increasing-frequency-of-extreme-rainfall-events#:~:text=The%20research%2C%20published%20in%20Nature%20Communications%2C%20found,frequent%20by%202080%20compared%20to%20the%201980s.

Impact of Surface Water Flooding

This report does not include the effects of surface water (pluvial) flooding, either now or due to changing climate. Surface water flooding is a very significant hazard to Shrewsbury and the costs to Shrewsbury businesses are therefore significantly underestimated due to not including the effects of surface water flooding.

Impact of Groundwater Flooding

There are some significant impacts from groundwater in Shrewsbury which are not considered in this report because they are not included within the scenarios considered in the IA.

This study has revealed that in fact there are many business premises that suffer from groundwater flooding. However, such processes are intimately connected with river flooding processes, and a more comprehensive study is required to ascertain the overall sources and impacts more adequately than has been done hitherto if an effective mitigation strategy is to be achieved.

This report does not include damage or business losses due to groundwater flooding because of the need to compare "like for like" with the IA. Many of the most flood-impacted properties in Shrewsbury suffer from groundwater flooding (basement flooding), mostly due to the process known as 'permeable superficial deposits flooding' where:

a. "groun*dwater in permeable superficial deposits (PSD) is in good hydraulic contact with a river, flooding can occur during periods of high river stage*" as described further by GeoSmart[23].

b. Relict subsurface infrastructure such as sewers and drains in old towns such as Shrewsbury commonly form conduits for enhanced permeability and pipe flow through unmapped hydraulic connections between the river and business premises which may lie some distance from the river bank. This network of enhanced permeability (termed 'Urban Karst')[24] and observations made during this study shows rising river stage is correlated with almost immediately rising groundwater within lower ground floor and basement premises nearby.

c. Observations made during site visits during this study confirm the flooding of many of the most badly damaged business premises in Shrewsbury to be suffering from significantly more frequent flooding than that reported by the Environment Agency. This phenomenon is characteristic of permeable superficial deposit flooding and has been described by GeoSmart[23] as sites that are "*prone to groundwater flooding even if it is protected from overland fluvial flooding. In conditions of less extreme floods, groundwater flooding often occurs in flood plains due to high in-channel river levels, before the river overtops its bank, or after it has retreated back into its channel. It is therefore often difficult to distinguish from river flooding. Effectively, the subsurface flow path results in more*

[23] https://geosmartinfo.co.uk/data-and-services/groundwater-flood-risk-map/

[24] Journal of Hydrology Volume 552, September 2017, Pages 141-150. Stormwater infiltration and the 'urban karst' – A review, by Jeremie Bonneau, Tim D. Fletcher, Justin F. Costelloe, Matthew J. Burns

extensive, frequent, and prolonged inundation". The consequences of this little recognised phenomenon are very significant in terms of damage, both due to the considerably increased frequency of flooding (which is therefore not adequately described by reference to the river flooding likelihood (refer, for example, to the Salopian Case Study, where frequency of flooding has been reported of the order of ten times the frequency of river flooding reported by the Environment Agency). The standard approach to damage assessment is inadequate both because of the increased frequency and also due to the typically longer duration of flood events, leading to disproportionately higher damage characteristic of groundwater flooding.

In relation to flooding characteristics, because groundwater flooding occurs at times of high river levels even when the River Severn does not overtop, this also means that flooded properties at risk from groundwater are often impacted for longer than other properties as a result of the long persistence of high groundwater levels.

Groundwater is a very significant hazard to Shrewsbury (as described in some of the case studies in Appendix E) and the costs to Shrewsbury businesses in Flood Defence Grant in Aid (FDGiA) are therefore significantly underestimated due to not including the effects of groundwater flooding.

Groundwater flood risk is a hidden risk within the current regime established by the Flood and Water Management Act (2010) because the Act defines groundwater as 'Local Flooding' and gives responsibility for flood risk management to the LLFA, which has an administrative jurisdiction whereas groundwater systemically is not local flooding but instead a catchment process at the heart of river flooding and requires a catchment approach integrated with river flooding to assess the risk.

The IA addressed the consequences in loss and damage due to overtopping of the river banks and this is the focus of the Environment Agency in relation to flood warning and risk management response, whereas from this study it can be seen that the experience of the businesses flooded reflects the impact of the overall flood hazard which results from a dynamic interaction of surface water, river and groundwater, demonstrating that the frequency analysis and flooding pathways considered by the IA do not match the experience of those flooded and need to be considered more holistically. They are not adequately represented by the prevailing river modelling alone.

The alternative paradigm offered by this work and wider national studies of GeoSmart[25], British Geological Survey[26] and others offers a more complete description of the source-pathway-receptor flood hazard linkages of significance to businesses in Shrewsbury and more widely to the local community in Shrewsbury and elsewhere.

Consideration of this refined conceptual model of Shrewsbury hydrology will help provide the more complete description of flood risk in Shrewsbury that is needed to underpin future more complete flood risk assessment and management response scenarios.

[25] https://geosmartinfo.co.uk/risk-management-for-financial-services/floodsmart-analytics/

[26] https://www2.bgs.ac.uk/groundwater/flooding/home.html

Comments on the overall flood risk in Shrewsbury

There are several sources of flooding in Shrewsbury but the main hazard of concern and sole focus of the IA was overtopping of the banks of the River Severn, leading to the focus of the IA exclusively on assessing the losses and damage due to river flooding.

This study has revealed, contrary to expectations, that in fact there are many business premises that suffer from groundwater flooding (the prevalence of surface water flooding is particularly widespread but has not been discussed in this report).

A suitable and more holistic study is required to assess the flood risk and impact of changing climate on Shrewsbury businesses from all sources of flooding before a more adequate flood mitigation strategy can be achieved. The significant harm being suffered by Shrewsbury businesses demonstrates urgency for this study to be completed.

Mental Health

Mental health effects are recognised as a significant burden. Whilst the impact on the mental health [27]of residents of flooded property is already recognised in the Arup's IA, there has not been any assessment of the mental health impact on those who own or work in Shrewsbury businesses.

Overall Impact on Trade in Shrewsbury

The impact of lost working days and trade impact on businesses that suffer flooding has been estimated in this study, but the wider impact on businesses that are not directly flooded but suffer from reduced footfall and vehicle access during flood events and their aftermath has not been included in the analysis.

Footfall and reduced vehicle numbers during flood events of 2020 and 2022 suggest a 25% loss of trading in Shrewsbury town centre (Appendix D "Reduction of Sales during flood events") for at least a week in each of these years. A similar pattern annually would suggest a very significantly increased loss to businesses in the wider business community in town, albeit direct comparison will require average annual loss analysis and this needs further review.

[27] DEFRA Guidance - https://www.gov.uk/government/ publications/partnership-funding-supporting-documents/mental-health-costs-of-flooding -and-erosion

7 Conclusions

The main conclusions reached in this study are:

1 The analysis has been completed using the Frontier's Toolkit, which indicates that in comparison to the FCERM GiA methodology losses (estimated at a present value of £25.8M), losses to Shrewsbury businesses of the order of £14.25M (an additional 55%) has been overlooked, and a more complete estimate is £40.5M loss on the basis of the Frontier's method.

2 Other sources of losses have been identified in this study but are not considered in the approach used in this limited desk study. The limited evidence available demonstrates that losses to businesses from other flooding sources (particularly groundwater) are very significant, (and in particular the damaging impact on the local economy of reduced trading before, during and after flood events) it is likely that such losses from other flooding sources and wider economic impacts in the town will contribute to overall losses more than twice that counted by the prevailing FCERM GiA methodology. Such an estimate needs to be verified through a more detailed study.

3 The prevailing FCERM GiA methodology used for Shrewsbury and elsewhere means that losses being suffered by the local business community are not recognised when flood alleviation decisions are being made by the local risk management authorities.

4 Using the Frontier's toolkit provided an appropriate assessment methodology to quantify the losses due to damage to business premises and business interruption as an additional source of losses relative to the FCERM GiA method.

5 The accuracy and completeness of this study is not sufficient to quantify losses on a directly comparable basis to the prevailing FCERM GiA methods, but does provide an order of magnitude estimate to support the business case for further work, demonstrating that more in depth study will be appropriate and it is likely that better flood risk management will be achieved if cost-benefit analysis is conducted including such losses to business in the future.

6 The business survey demonstrated that a significant part of the business losses relates to extended closures of businesses at times when local authority and media communications suggest Shrewsbury is flooded and visitors should avoid the area, even when there is not flooding or related access problems. The situation is exacerbated by errors associated with computer forecasts at the Crew Green gauge, which local businesses rely on and which often significantly over-predicts levels in the forecast. The Environment Agency advises to check for flood warnings rather than rely on these predictions, which come directly from a computer model and are not refined by a flood forecaster.

7 This analysis did not look at the properties that may close or move away from Shrewsbury if flooding is allowed to continue. Frontiers methodology can be extended to evaluate the significance of these potential losses to the total economy

and also the attraction of businesses to the town centre if flooding was significantly mitigated.

8 Part of the lost revenues for local businesses are due to communications which suggest the town is closed due to flooding when for most of the time access is still possible. Improved communication between the various stakeholders such as Highways teams, Shropshire Council communications team and the Environment Agency has the potential to reduce the duration of town closures and thereby reduce business losses significantly.

8 Recommendations

Our recommendations are as follows:

1. The losses to Shrewsbury businesses are significantly more than is recognised in the prevailing FCERM GiA methods and should be recognised as the basis for improved flood risk management in Shrewsbury.
2. Risk management responses considered hitherto for Shrewsbury have been insufficient to the extent that previous cost-benefit analysis has not included recognition of business losses and property financial damage identified in this study. Cost-benefit analysis in support of future flood alleviation proposals should consider the additional categories of business damage and losses identified in this study.
3. The approach used in this study should be used in a more comprehensive assessment to provide additional evidence to justify flood alleviation proposals and should particularly help when seeking partnership funding.
4. Improvements to communication before, during and after potential and actual flood events are recommended. Improved communications offer the potential to significantly reduce business interruption and loss of trade.
5. Improved early warning of upcoming flood events can potentially save very significant costs to Shrewsbury businesses and the local economy. There is significant scope for enhancing the warning service provided by the Environment Agency, Shropshire Council and others. The Environment Agency is currently updating their flood warning service[28], and opportunities should be sought for increased information to be available at all times and well publicised through the business groups and other local stakeholder groups. Improvements are also urgently required to the Crew Green forecast[29] to enable more realtime accuracy in forecasts to be made available to Shrewsbury businesses (for whom Welsh Bridge forecasts do not provide enough advance warning of upcoming events to enable adequate response time).
6. This study has provided a preliminary analysis on the basis of existing information that has confirmed costs to businesses are significantly more than has been hitherto estimated.
7. A suitable study is required to assess the flood risk and impact of changing climate on Shrewsbury businesses from all sources of flooding.
8. A more comprehensive economic analysis is also recommended to provide a fuller understanding of the cost of flooding to Shrewsbury businesses as the basis for considering options for improved flood risk management in the area.

[28] Dave Edwards, pers. Comm. 1 August 2025

[29] https://check-for-flooding.service.gov.uk/station/2067

9 Appendices

Appendix A

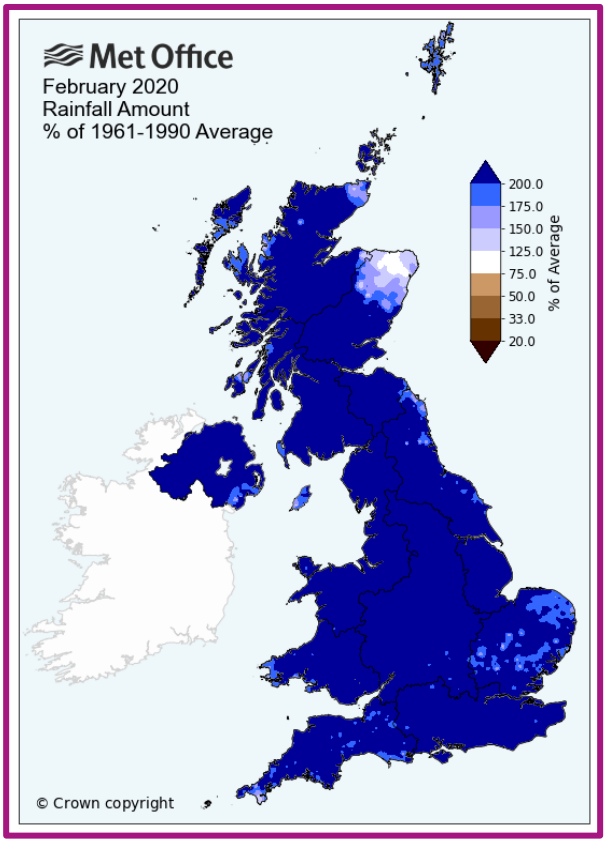
Recent Flooding in Shrewsbury

February 2020

The winter of 2020 marked the 5th wettest winter on record, with the UK recording 209 mm of rainfall, roughly 237% above the average rainfall expected (Met Office, 2020) and the wettest February on record for England, Wales and Northern Ireland. The UK was hit by extreme weather, including three named storms, including Storm Ciara, Dennis and Jorge.

Shrewsbury suffered significant flooding from high water levels and subsequent overtopping of the River Severn during Storm Ciara (2nd – 16th February 2020) and Dennis (13th – 19th February 2020) which caused significant damage and disruption. 381 properties are recorded as having some level of damage or disruption according to data collected by Environment Agency and referenced in the Arup IA.

Figure 1. February 2020 monthly rainfall amount (Met Office, 2025)



8th February 2020 - Storm Ciara hits the UK, causing high winds and heavy rain across England and Wales.

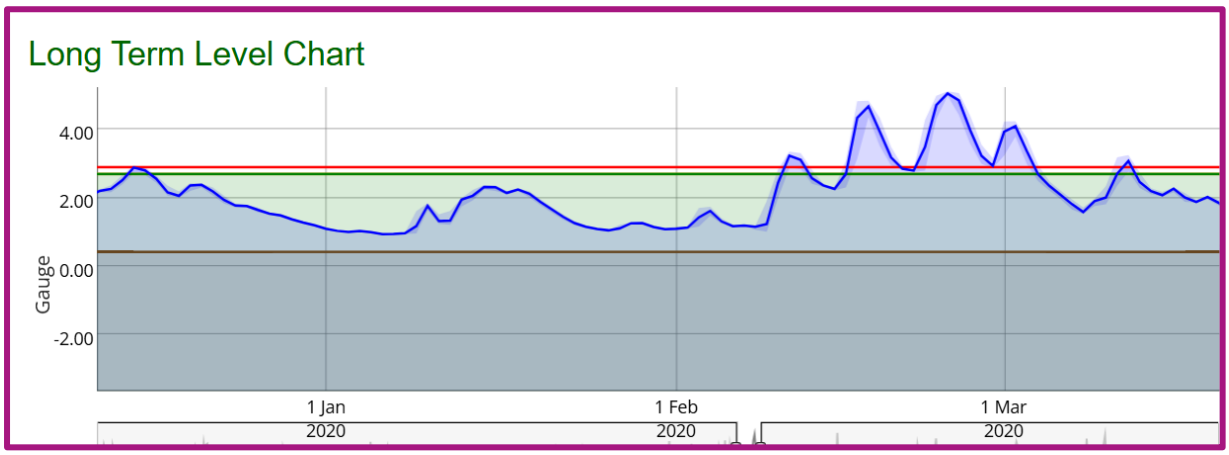
15th February 2020 – A more powerful storm, Dennis, hits the UK and devastates central England and Wales particularly badly.

16th February 2020 – Shropshire Council declare a major incident. Flood warnings are issued across the Severn Catchment.

22nd February 2020 – Two severe flood warnings are issued for the River Severn at Shrewsbury, indicating a threat to life.

25th February 2020– The gauging station at Crew Green records its highest level of 6.55 m above gauge datum, just under the previous record of 6.57 m set in 2000. At Welsh Bridge levels reached 5.15 m above board datum (0.1 m below the record for the station set in 2000).

Figure 2. Early 2020 river levels at Welsh Bridge recorded by the Environment Agency



The prolonged rainfall led to extreme flooding in Shrewsbury, where a Shropshire Council report estimated the cost of responding to the floods approached £520,000 whilst incurring *"unavoidable capital costs of at least £2.74m"* (Shropshire Council, 2020) including 526 business grants of up to £2,500 to businesses in Shrewsbury. The distribution of flood impacts on property is illustrated on Figure 3.

Figure 3. Location of buildings that experienced flooding from February 21st - 25th 2020 (taken from ICEYE, 2021)

February 2022

In February 2022, Storms Dudley, Eunice and Franklin hit the UK, leaving 1.4 million households without electricity and caused widespread flooding. This was the first time three named storms hit the UK within a seven-day period (Met Office, 2022).

On the 20th of February, a total of 11 flood warnings and 12 flood alerts were issued by the Environment Agency, whilst Shropshire Council closed a number of roads including Berwick Road, Coleham Head and Longden Coleham (Shropshire Council, 2022).

Figure 4. Aerial imagery of Shrewsbury flooding in February 2022 (MyShrewsbury, 2022)

The gauging station at Crew Green set a new record of 6.58 m on the 21st February 2022, resulting in the closure of Frankwell, St. Julians Friars, Abbey Foregate and Raven Meadows car parks following extreme flooding. As floodwater receded, the clean up operation was well underway on the 25th February 2022, while roads and car parks began to open again (Shropshire Council, 2022).

Figure 5. February 2022 monthly rainfall statistics (Met Office, 2025)

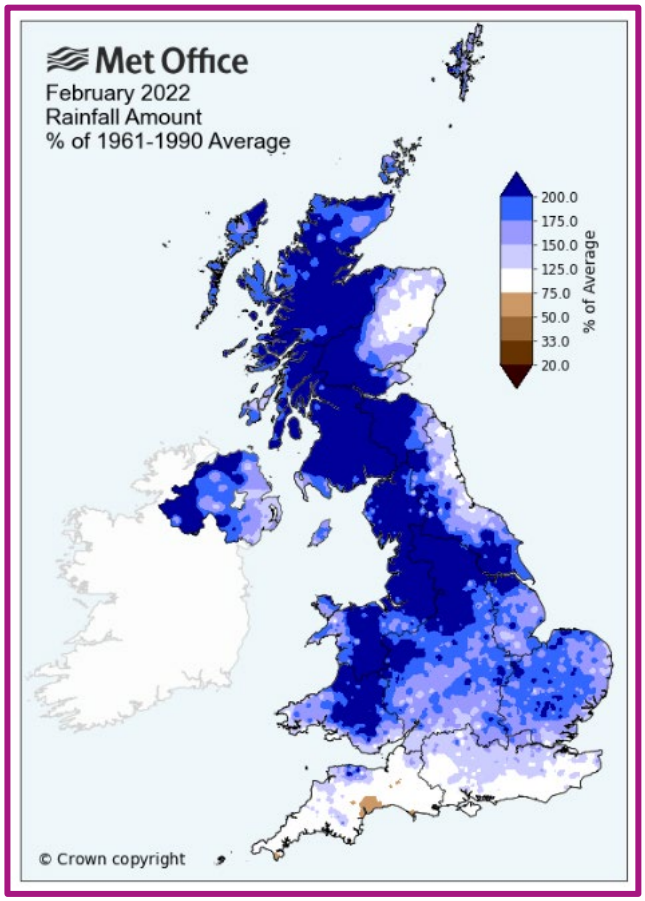
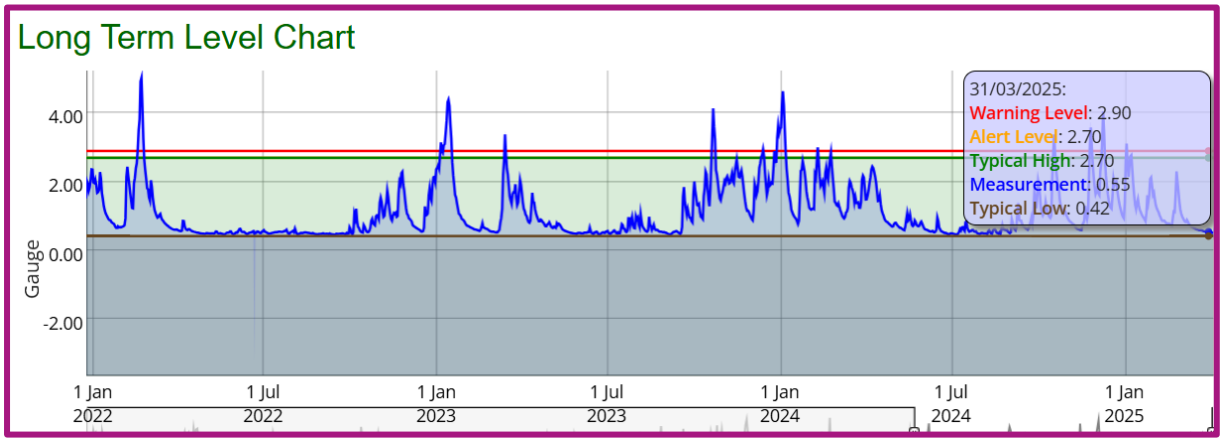


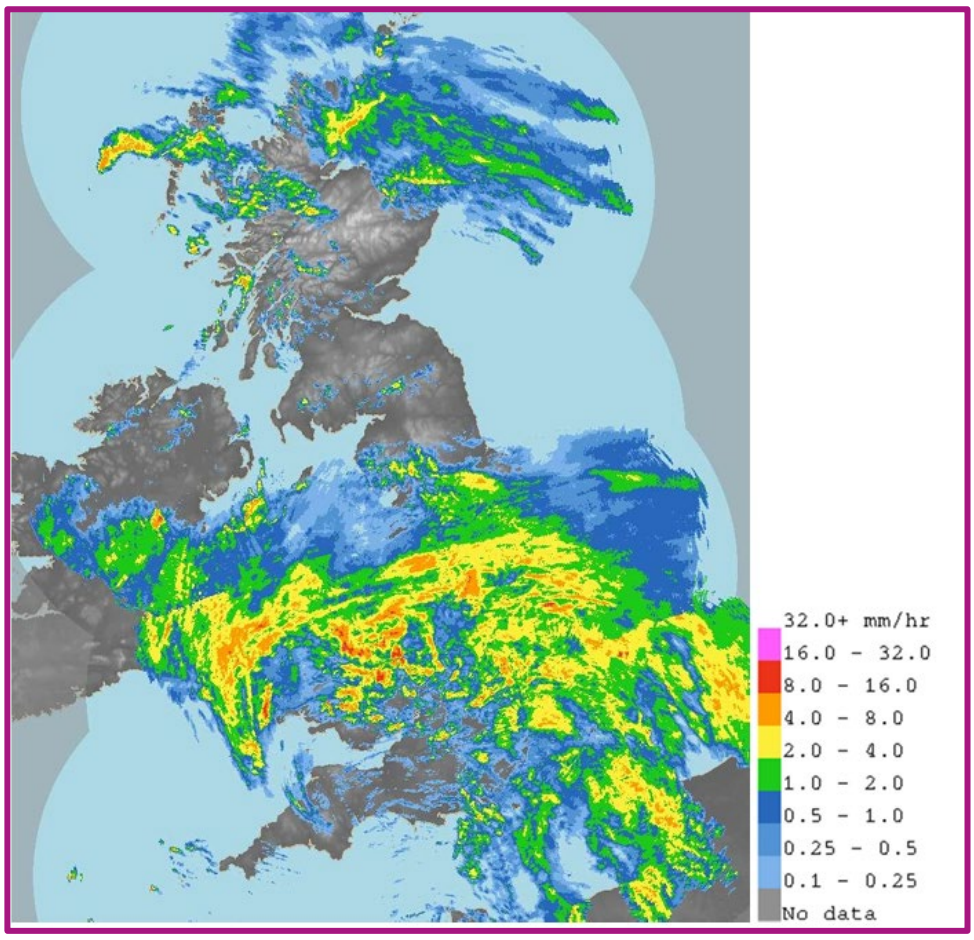
Figure 6. 2022 to 2025 river levels at Welsh Bridge (Environment Agency)



January 2024 (Storm Henk)

The new year began with yet another named storm, the eighth named storm of the 2023-2024 storm season, hitting the UK on the 2nd January 2024. Storm Henk brought strong winds and extremely heavy rain, leaving an estimated 38,000 homes without power and triggering over 300 flood warnings in England (Met Office, 2024).

Figure 7. Rain radar image of the UK taken at 12:00pm on 2nd January 2024 and daily rainfall totals throughout Winter 2024 (Met Office, 2024)



The prolonged heavy rainfall saturated ground levels, increasing runoff entering the Severn catchment and causing already high river levels to rise further. Monkmoor rainfall gauging data recorded 22.60 mm of rainfall on 2nd January 2024, whilst river levels at Crew Green rose to 6.46 m above gauge datum on 3rd January 2024.

Flooding caused a power cut and subsequent closure of the Shrewsbury bus station, which in addition to several car parks that were closed until 8th January 2024 with the exception of Frankwell, where clean-up operations were still on-going.

Figure 8. Flooding in Coleham following Storm Henk (Shropshire Star, 2024)

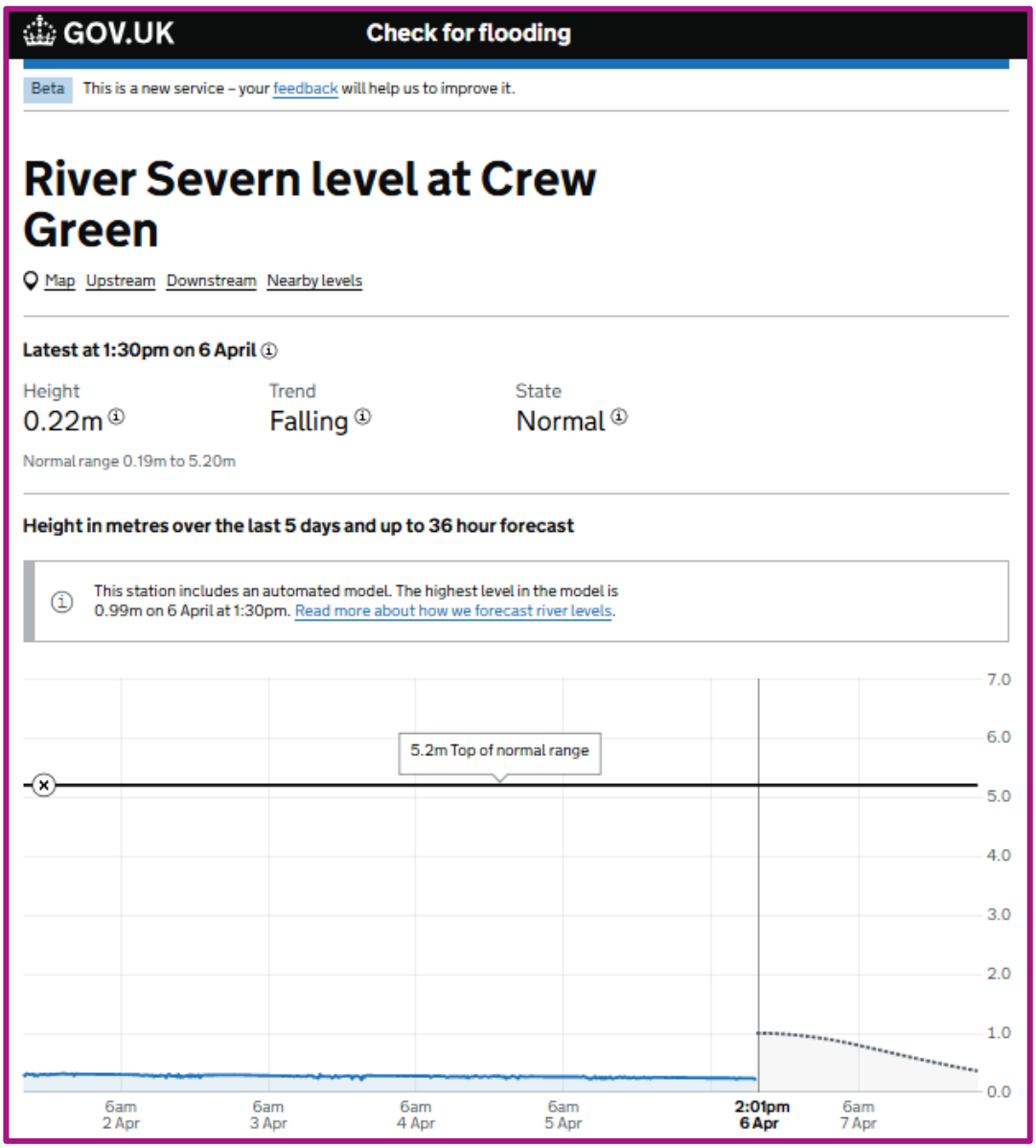
A note on river level monitoring and forecasting

Businesses rely on gauging stations on the River Severn for early warning of impending flooding events. Welsh Bridge in Shrewsbury and upstream at Crew Green include forecasts provided by the Environment Agency in the form of modelling predictions online which provide 36 hours forecast.

Welsh Bridge does not provide sufficient early warning for local businesses to take action to protect their premises, so many rely on the Crew Green gauging station.

There is a problem with lack of calibration of the forecast at Crew Green, which typically shows an incorrectly over-predicting forecast with a step change such as that shown in Figure 9.

Figure 9. Crew Green river level record and example forecast (Environment Agency gauge)



During flood events the errors at Crew Green can be significantly larger. For example, during the 2020 flooding, Crew Green incorrectly predicted a maximum river level of 11.35 mAOD, causing widespread panic in the town (Shropshire Council, 2021).

Business losses are increased when flood events are over-predicted or unnecessary precautions are taken, so the errors at Crew Green impose a significant burden of cost on local businesses.

Appendix B

Project appraisal for flood alleviation schemes

In Shrewsbury there has already been an Initial Assessment (IA) focused on outline flood alleviation scheme proposals[30]. This has used the standard FCERM GiA Partnership Funding (PF) calculator and suggests that some scheme options could score above 100% for protecting some parts of Shrewsbury adjacent to the River Severn.

Based on the proposed contribution to outcome measures and the costs of the project, the PF calculator produces a raw PF score. This gives a percentage score of how likely (eligible) FCERM GiA is to fund a particular project or option. Similarly, the adjusted PF score shows the extent to which the available FCERM GiA and any proposed financial contributions are enough to fund a particular project or option.

The raw PF score is an indicator of the efficiency of FCERM GiA investment. A raw PF score below 100% shows that there is insufficient eligible FCERM GiA available from the qualifying benefits to fully fund the project. This may be because project costs are relatively high or because qualifying benefits are relatively low. In these circumstances, financial contributions (based on other local or national benefits and outcomes) or cost efficiencies can increase the PF score to, or above, 100%.

Some possible schemes to provide additional flood alleviation could demonstrate increased viability if the additional outcomes assessed in this study were factored in. This is not currently done, but the analysis presented in this report illustrates there may be scope to do so in the future.

The prevailing methods of economic analysis follow a strict protocol for justification of flood alleviation expenditure in England. Whilst the Treasury Green book[31] details the procedures for investment in public sector infrastructure projects, there are specific documents and data sets that relate to the investment in flood alleviation projects:

- FCERM (Flood and Coastal Erosion Risk Management) appraisal guidance: appraisal guidance and supporting information when preparing a proposal, strategy or business case, Environment Agency, updated May 2022
- The Multi-Coloured Handbook (MCM), Flood Hazard Research Centre, Middlesex University May 2024
- Partnership Funding (PF) for Flood and Coastal Erosion Risk Management Grant-in-Aid (FCERM GiA), updated in April 2022
- National Receptor datasets (NRD) lists properties and their MCM code in any selected flood plain, Environment Agency (updated 2023)

[30] Initial Assessment Shrewsbury final version 26 May 2021. Arup and Partners report to Environment Agency
[31] HM Government and Government Finance Function updated May 2024 The Green Book: appraisal and evaluation in central government:
HM Treasury guidance on how to appraise and evaluate policies, projects and programmes.

The MCM is a handbook and data sets for evaluating the potential damage and loss of a range of receptors at risk from flooding, from residential and commercial properties, utilities, communications etc. It is updated annually in May with corresponding damage data for receptors at risk.

The data for properties is in the form of an assembly of potential damage by depth of flooding, and duration. An assembly of actual property damage is sporadic and only available following each flood event. The appraisal method uses depth/damage curves for different types of property (See Table 1 for Non-residential or commercial types). This data is available to consultants via www.mcm-online.co.uk. The data has been collected and updated since 1978, breaking damage components into building fabric, stock, fixed and moveable equipment and clean up by square metre of floor space. The data is endorsed by The National Flood School in Wallingford, Oxfordshire[32].

Table 1. Property types and codes used in flood depth damage calculations in MCM

Non Residential	
2	Retail
3	Offices
4	Warehouses
5	Leisure and sport
51	Leisure
52	Sport
521	Playing Field
523	Sports Centre
526	Marina
525	Sports Stadium
6	Public Buildings
8	Industry
9	Miscellaneous
910	Car park
960	SubStation

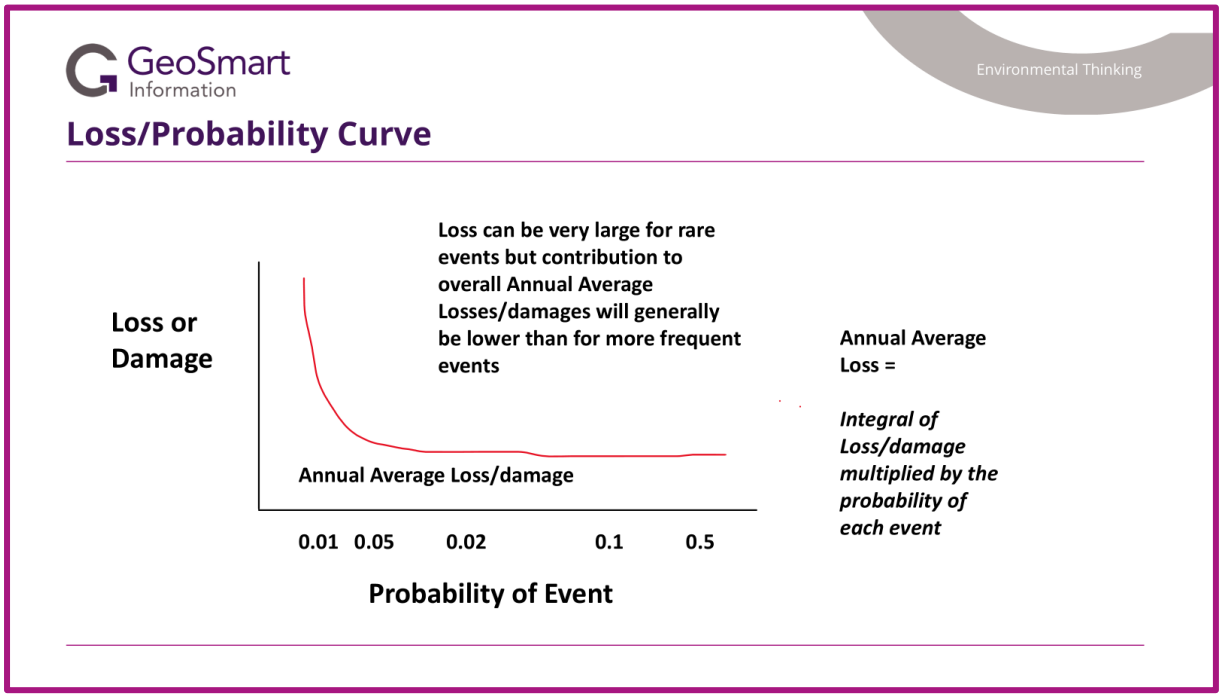
Benefits of flood scheme construction are the calculation of annual average damage expected from a range of floods of different probabilities, rather than actual though often incomplete damage from a single or random event. There are examples of the process in the public section of the MCM website.

Benefits over a time period, usually 50 years, are compared with the whole life costs of flood alleviation measures and value for money established through a benefit cost ratio. The concept of Annual Average Damage (AAD) is the area beneath the Loss/Damage probability curve integrating all damage from a number (minimum of 5 preferable) of rare to frequent theoretical events. The depths of flooding from these theoretical events to each property in

[32] https://nationalfloodschool.co.uk/ Leading the nation's training in flood restoration, fire restoration and mould remediation for 35 years.

the Shrewsbury flood plain area were calculated by Arup's using hydraulic and hydrological modelling data[33]. Figure 1 illustrates the Loss/probability curve.

Figure 1. The Loss/Probability Curve



The hydraulic model for Shrewsbury included the 5,000-, 100-, 50- and 25-year events with a threshold of flooding of 4.5 years. The benefit of any scheme is the damage avoided by the scheme; so, a scheme to avoid all damage to a 100-year event would have a small residual damage for much rarer events.

However, the benefits are weighted according to Government's perceived priority using a Partnership Funding Process allocating proportionate benefits to Outcome Measures.

Outcome Measure 1A (OM1A) (see Table 2) relates to all benefits except residential benefits and attracts funding via FCERM GiA of 6p in the pound[34]. Residential properties and auxiliary health issues OM1B attract 20p in the pound and furthermore residential properties in the most deprived areas attract supplementary funding. Business Losses however are NOT included in the OM1A as from a National standpoint most of the losses incurred during flooding are likely to be made up by deferring purchases or services to a post flood date or transferring these purchases and services to a non-flooded area.

This means that business losses to premises operating in Shrewsbury are not included in the appraisal process.

[33] Arup Shrewsbury Initial Assessment Final 26 May 2021

[34] In the Environment Agency (EA) Partnership Funding Calculator, "20p in £" typically refers to the proportion of funding that a project can receive from the government for every pound of benefits it delivers. For example, if a project generates £1,000 worth of benefits, it might be eligible for £200 of government funding under a "20p in £" rate. This calculation helps determine the level of additional partnership contributions required to fund flood and coastal erosion risk management projects

Table 2. Outcome measure 1 (Partnership Funding Calculations)

Outcome Measure 1 Payment tariffs		
People related FCERM benefits (risk to life, stress and health, mental health, vehicle damages avoided, residential evacuation costs) - OM1B	20	p / £1
Overall FCERM economic benefits - OM1A	6	p / £1

Using the contribution formulae[35] a raw Outcome Measures score to indicate the likely level of FCERM GiA and Local Levy funding is derived. An adjusted Outcome Measures score is required once the likely funding level from the Local Authority, and any other potential contributors, is known. From a businesses' perspective there is an important requirement to investigate the damage and the likely Business Losses so a contribution might be made to offset any shortfall based on the original Outcome Measures score.

In this study damage is estimated from both an economic or National UK plc perspective but also from a financial (or local) perspective with additionality of benefits accruing to the local and wider Regional community. For example, loss of business added from the properties in the four flood zones (Coton Hill, Coleham, St Julians and Smithfield) within Shrewsbury would not be counted in an economic appraisal, as lost business to these businesses may either be transferred to other companies elsewhere in UK or deferred until the site becomes flood free. Damages at a local level more closely reflect insurance losses and these are calculated as financial damage.

Financial damage as estimated for Defra 'Who benefits' project[36] can be as much as 52% greater than economic damage for Non-Residential (commercial) properties. Generally, for Stock and Work in Progress financial damage are equal to economic damage.

[35] Environment Agency Operational principles to follow when setting up funding partnerships to tackle flood and coastal erosion, January 2024

[36] HR Wallingford Ltd. in association with Flood Hazard Research Centre and JB Chatterton & Associates Who Benefits from Flood Management Policies? R&D Final Report FD2606, 2008

Business Losses using the Frontiers Toolkit

The principles of the Frontiers Toolkit are outlined in the report above.

A further important aspect of business loss is additionality, which is described in detail below.

Additionality

Data on GVA is supplemented by economic multipliers to reflect the loss of income to the wider sub-regional economy from flooding using guidance from the Homes and Communities Agency (HCA) Additionality Guide Fourth Edition 2014[37]

Economic multiplier effects refer to further economic activity (jobs, expenditure or income) associated with additional local income and local supplier purchases. There are two main types of multiplier effects:

- Supply linkage multipliers (also referred to as indirect multipliers) – these account for purchases made as a result of the intervention and further purchases associated with linked firms along the supply chain.
- Income multipliers (also referred to as consumption or induced multipliers) – local expenditure generated by employees, e.g. food and drink purchased during their lunch break, or income foregone in properties whose access is reduced during flooding through reduced footfall.

Agglomeration is key where businesses are more profitable due to their location within clusters, sharing knowledge, ideas and skills. Flooding which affects one business within the cluster could have a widespread impact on the others;

The Homes and Communities Agency (HCA) Additionality Guide provides a range of ready reckoners according to the strength of economic multipliers and the geographical level used for the assessment (neighbourhood and regional):

Table 3 gives Neighbourhood and Regional level multipliers for three scenarios. As County town for Shropshire a multiplier of 1.7 is applied to GVA loses. Due to local connections being a strong factor in local trade

Table 3. Additionality Multipliers

Level	Multiplier	Neighbourhood level multiplier	Regional level multiplier
Low	Limited local supply linkages and induced or income effects	1.05	1.3
Medium	Average linkages. The majority of interventions will be in this category	1.1	1.5
High	Strong local supply linkages and income or induced effects	1.15	1.7

[37] http://www.homesandcommunities.co.uk/publications

Two scenarios from the Frontiers approach are considered

Scenario A: Loss of GVA for a single flood event

[Earnings x No. of employees] x Disruption length (Equation1)

Where:

Earnings = Average projected annual pre-tax earnings per employee

No. of employees = Number of employees working for the business at the flooded site

Disruption length = Assumed length of disruption in days

Annual Average Loss of GVA is calculated using Loss probability curve (see Figure 2)

Scenario B: If the business closes down because of flooding

Average Annual Earnings per employee x No. of jobs in business that would move / shut down (Equation 2)

This value is multiplied by the discount rate to get the Present Value of damage and business losses for the whole appraisal period over a 50 year time period

LOCAL BUSINESS IS LOST FOREVER

Scenario B would need further in-depth discussions with properties indicating they might consider leaving the BID area

Business reaction to flooding is theoretically as follows:

Stay and Do Nothing

- Generally, with businesses with a low adaptive capacity, (Equation 1 applies)

Stay and Adapt

- Generally, larger corporate businesses who introduce resilience measures or business continuity plans to reduce future losses

Move or shut down

Limited numbers (Equation 2 applies). Costs of the move to another location should also be considered in this scenario

Establishing the length of outage either through flooded properties and restricted access is tricky. It might be considered that the deeper the flooding the longer the outage, though Frontiers use a rule of thumb (Table 4) if local experience is not available

Table 4. Frontiers rule of thumb for outage by employee numbers

Business Size (no. of employees in UK)	Disruption Period	Notes
• Micro (< 10)	24 weeks	Unlikely to have the resources to adapt prior to the event or recover quickly after the event. Building repairs likely to be more significant.
Small / Medium (11 – 199)	4 weeks	Some adaption / preparation prior to the event may have been possible.
Large (200+)	2 weeks	Most likely to have the resources to adapt prior to the event or recover quickly after the event.

From experience the most protracted outages for commercial properties are for independent small retail establishments. Properties as part of a corporate business generally are quickest to return to business as usual.

Empirical evidence of outage to commercial properties has been the subject of research. Devonomics (2013)[38] found that of the 600 businesses they surveyed across Devon and Somerset, 18 temporarily closed following the floods of 2012/2013. These closed for a total of 342 days collectively, suggesting an average length of closure of 19 days. It also found that on average 10 working days were lost per business as a result of the floods. This suggests a range of 10 – 20 days (2-4 working weeks)

Crichton[39] (2006) found that in a survey of 2,420 businesses on average, businesses took over two months to re-open following flood events. Crichton also found that among small businesses, the average length of business interruption as a result of flooding was 15 months in 2005, up from 8 months in 1996. This suggests an indicative range of 8 – 65 weeks.

In summary, the differences between financial and economic damage is critical, but FCERM GIA assessment methods largely ignore local business losses and potential financial damage.

There is therefore a need to recognise business losses to enable a more complete assessment, and application to cost-benefit analysis, and use of the MCM Financial damage and the Frontier Toolkit methodology provides an appropriate method.

A ready reckoner (Table 5) calculates Business Losses varying the length of outage and number of employees using the £105 GVA per employee per day (median value for Shropshire Unitary Authority).

[38] Devonomics (2013), "Impact of flooding on key business sectors in Devon and Somerset 2012-13" Final Report, July 2013

[39] Crichton (2006), "Climate change and its effects on small businesses in the UK" reporting AXA Insurance surveys of small businesses 2006 survey

Table 5. Ready reckoner for business loss to each business in Shrewsbury

		Number of Employees						
	£	1	3	9	20	50	75	100
Days Outage	5	525	1,575	4,725	10,500	26,250	39,375	52,500
	10	1,050	3,150	9,450	21,000	52,500	78,750	105,000
	25	2,625	7,875	23,625	52,500	131,250	196,875	262,500
	30	3,150	9,450	28,350	63,000	157,500	236,250	315,000
	40	4,200	12,600	37,800	84,000	210,000	315,000	420,000
	50	5,250	15,750	47,250	105,000	262,500	393,750	525,000
		Look up of Gross Value Added flood outage costs by days outage and employees						

Appendix C

Questionnaire

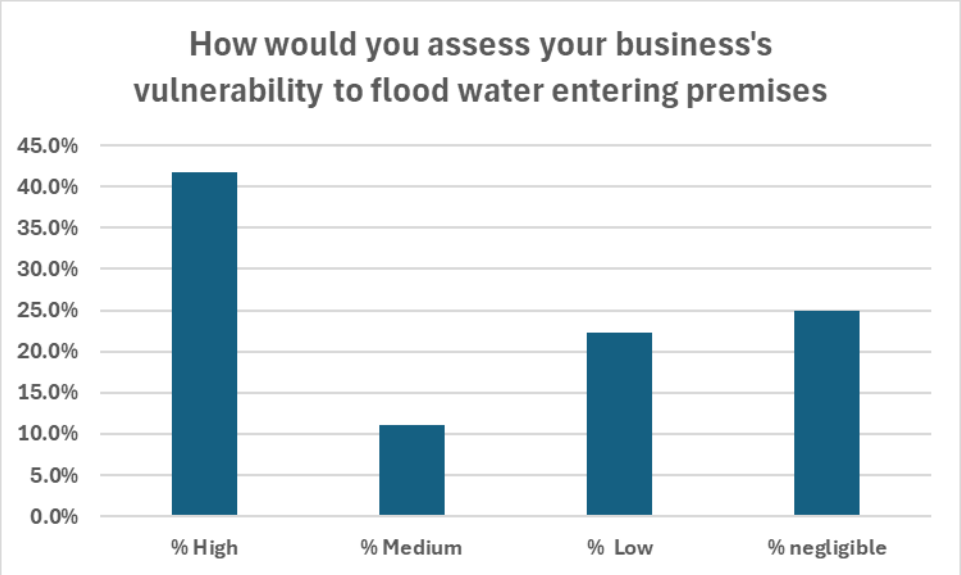
A detailed questionnaire survey was undertaken to help engagement with local businesses and acquire additional information to help shed light on the impact of flooding on the businesses of Shrewsbury. We are grateful to Stephanie Mansell-Jones of Shrewsbury BID for running this survey online.

A number of businesses volunteered to provide a more in-depth information through site visits and additional business data, and examples of these are presented in Appendix x as case studies.

The case studies further illustrate some of the problems faced by businesses in Shrewsbury and how they have sought to increase their resilience and incorporate active and passive flood protection in their premises and adopt flood action plans to help them survive flooding events.

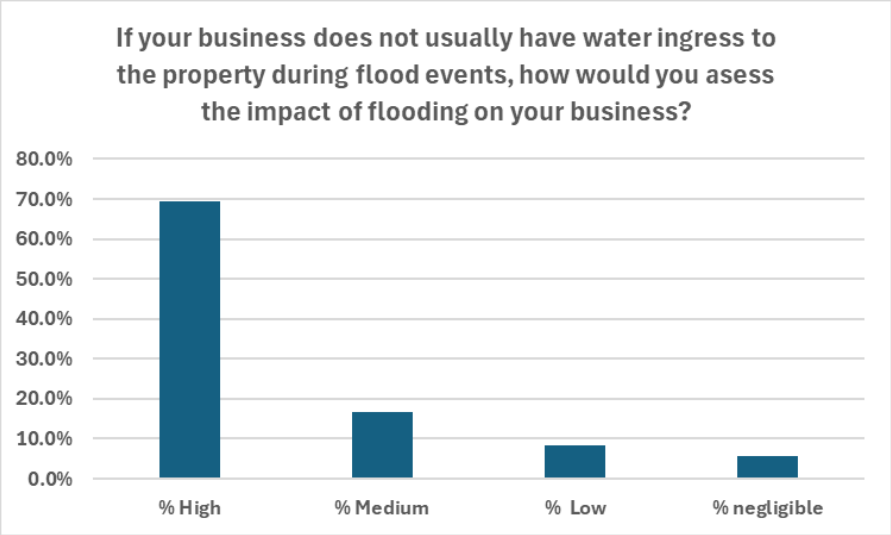
36 questionnaires and 8 case studies were analysed and results presented in this section.

	High	% High	Medium	% Medium	Low	% Low	negligible	% negligible
How would you assess your business's vulnerability to flood water entering your premises?	15	41.7%	4	11.1%	8	22.2%	9	25.0%



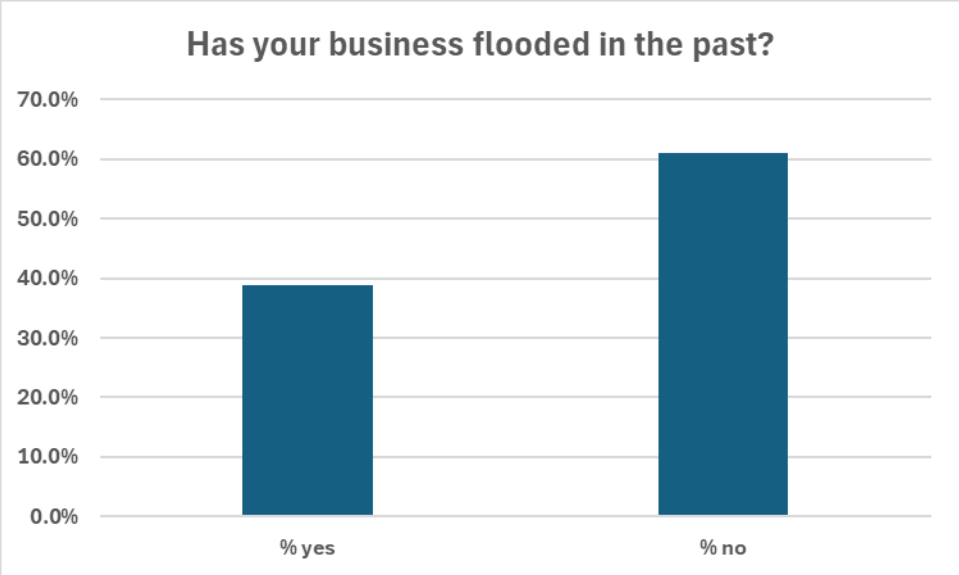
Over 50% of respondents suggested either high or medium vulnerability to flood water entering their premises. However, all except one premises experienced loss of trade, access restrictions, reputational damage to the town and reduced footfall.

	High	% High	Medium	% Medium	Low	% Low	negligible	% negligible
If your business does not usually have water ingress to the property during flood events, how would you assess the impact of flooding to your business?	25	69.4%	6	16.7%	3	8.3%	2	5.6%



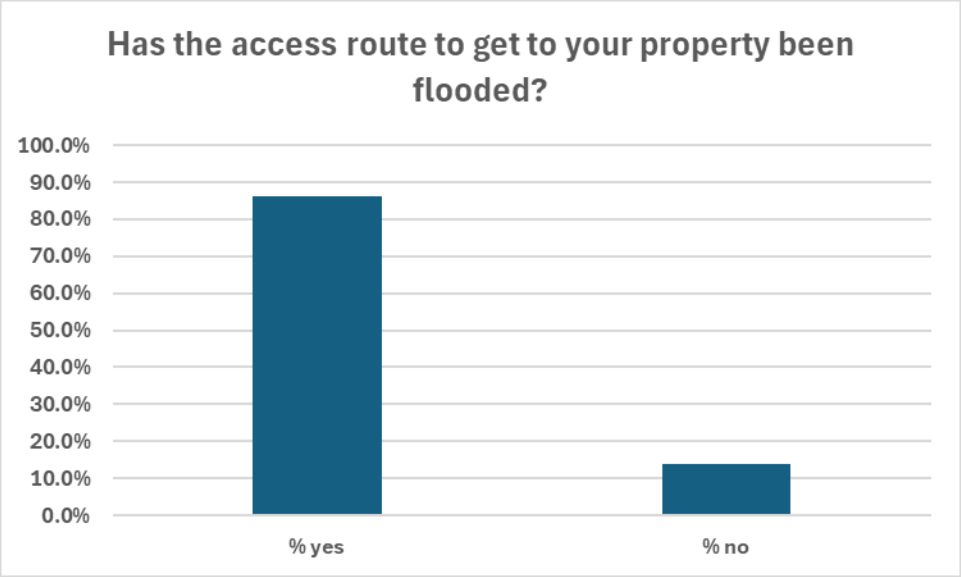
Almost 70% of respondents said the impacts on their businesses would be High even if water did not enter their businesses.

	Yes	% yes	No	% no
Has your business site been flooded in the past?	14	38.9%	22	61.1%



Of the 22 properties saying they have not had flooding in their property the mean loss of trade was around 5 days.

	Yes	% yes	No	% no
Has the access route to get to your property been flooded?	31	86.1%	5	13.9%



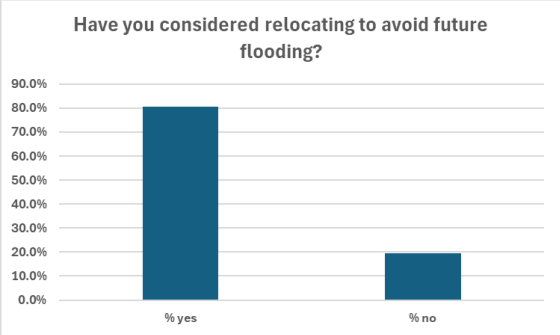
Almost 90% of respondents said that their access has been affected by flooding.

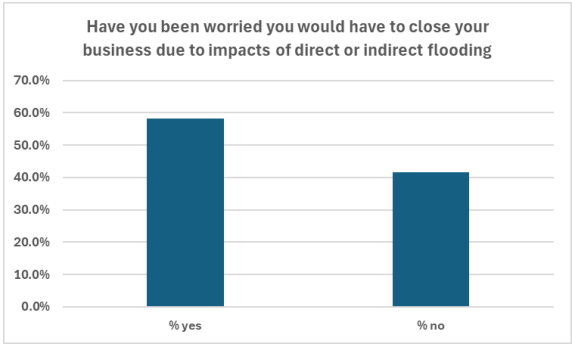
	Yes	% yes	No	% no
Have road closures around Shrewsbury impacted on your trade?	33	91.7%	3	8.3%

Over 90% of respondents said their trade has been affected by road closures

	Yes	% yes	No	% no
Could your business successfully operate in another location in Shropshire?	12	33.3%	24	66.7%

Two thirds of the respondents said they could not operate successfully in another location in Shropshire.





	Yes	% yes	No	% no
Have you considered relocating to avoid potential future flooding?	29	80.6%	7	19.4%

	Yes	% yes	No	% no
Have you been worried you would have to close your business due to the impacts of direct or indirect flooding?	21	58.3%	15	41.7%

Over 80% of the 36 questionnaire respondents have considered relocating to avoid potential future flooding and 58% have worried they would have to close their business due to the impacts of direct or indirect flooding.

The mean of businesses out of operation due to preparing for flooding, dealing with the flood and clean up afterwards is 7 days, though from experience more 'catastrophic' flooding would take longer to recover. However, the length of time trade was disrupted for properties whether flooded or access affected is 5.9 days, with a maximum of 21 days.

Over the last 5 years, the estimate of financial losses respondents have suffered due to loss of trade / access limitations / reputational damage to the town / lowered footfall is a total of £1,574,000 with a mean of £43,722 or around £315,000 per year with a maximum loss experienced by one respondent of £400,000 in a year.

Appendix D

Results of damage and business loss analysis

The Frontier Toolkit and MCM damage analysis were undertaken based on the properties identified by the Arup Initial Assessment so that the results can be compared to and added to the IA results on a like for like basis.

Modelled Annual Average Damage (and/or Losses) AAD/AAL

The Arup property data sets for flood depths, property types were used to develop both economic and financial damage estimates in the 4 sub areas affected by flooding. The Annual Average damage cells (See tables below) refer to the integration of the area under the curve in Figure 1. The "PV over a 50-year period" cells are the discounted values using HM Treasury discount rates to represent the accumulated Present value of Damages into the future[40]

The following tables are based on:

- Arup's analysis, which relied on existing Environment Agency hydraulic and hydrological modelling
- Receptor (Property) data from National Receptor Dataset extracted by Arup
- Depths for the return periods selected by Arup
- Economic damage for non-residential properties updated from MCM 2024
- Financial damage for non- residential properties updated from MCM 2024
- Business Losses to the flooded properties modelled by Arup's using the Frontiers methodology and assumptions as to length of outage and number of employees in premises
- A "Do Nothing" analysis assuming there are no mitigation measures in place in the four sub-areas

[40] Present value (PV) is the current value of a future sum of money or stream of cash flows. It is determined by discounting the future value by the estimated rate of return that the money could earn if invested. Present value calculations can be useful in investing and in strategic planning for businesses.

Coton Hill		S/A 1	Do Nothing		
Economic Damages					
AEP	1/AEP	Damage	Damage in Interval	Differnce in AEP	Annual Average Damage
4.5	0.22	0			
			180,271	0.18	32,849
25	0.04	360,541			
			843,903	0.02	16,878
50	0.02	1,327,265			
			1,919,242	0.01	19,192
100	0.01	2,511,219			
			4,623,534	0.0098	45,311
5000	0.0002	6,735,848			
			Total AAD		114,230
			PV over 50 years		2,821,492

Coton Hill		S/A 1	Do Nothing		
Financial Damages					
AEP	1/AEP	Damage	Damage in Interval	Differnce in AEP	Annual Average Damage
4.5	0.22	0			
			211,896	0.18	38,612
25	0.04	423,793			
			967,097	0.02	19,342
50	0.02	1,510,400			
			2,369,647	0.01	23,696
100	0.01	3,228,893			
			5,451,292	0.0098	53,423
5000	0.00	7,673,691			
			Total AAD		135,073
			PV over 50 years		3,336,310

Coleham		S/A 2	Do Nothing		
Economic Damages					
AEP	1/AEP	Damage	Damage in Interval	Difference in AEP	Annual Average Damage
4.5	0.22	-			
	-		708,899	0.18	129,177
25	0.04	1,417,799			
	-		2,281,999	0.02	45,640
50	0.02	3,146,199			
	-		3,796,358	0.01	37,964
100	0.01	4,446,518			
	-		6,072,242	0.01	59,508
5000	0.00020	7,697,966			
			Total AAD		**272,289**
			PV over 50 years		**6,725,533**

Coleham	S/A 2	Do Nothing			
Financial Damages					
AEP	1/AEP	Damage	Damage in Interval	Difference in AEP	Annual Average Damage
4.5	0.22	0			
			834,155	0.18	152,002
25	0.04	1,668,310			
			2,678,264	0.02	53,565
50	0.02	3,688,219			
			4,369,687	0.01	43,697
100	0.01	5,051,154			
			6,910,941	0.0098	67,727
5000	0.00020	8,770,728			
			Total AAD		**316,991**
			PV over 50 years		**7,829,677**

St Julians		S/A 4	Do Nothing		
Economic Damages					
AEP	1/AEP	Damage	Damage in Interval	Differnce in AEP	Annual Average Damage
4.5	0.2222	0			
			123,471	0.1822	**22,499**
25	0.04	246,942			
			227,143	0.02	**4,543**
50	0.02	879,486			
			772,951	0.01	**7,730**
100	0.01	1,656,071			
			2,422,712	0.0098	**23,743**
5000	0.0002	5,576,861			
			Total AAD		**58,514**
			PV over 50 years		**1,445,298**

St Julians		S/A 4	Do Nothing		
Financial Damages					
AEP	1/AEP	Damage	Damage in Interval	Differnce in AEP	Annual Average Damage
4.5	0.222	0			
			157,395	0.182	**28,681**
25	0.04	314,790			
			642,498	0.02	**12,850**
50	0.02	1,297,225			
			1,279,160	0.01	**12,792**
100	0.01	2,231,101			
			3,399,105	0.0098	**33,311**
5000	0.0002	6,507,561			
			Total AAD		**87,634**
			PV over 50 years		**2,164,552**

Smithfield		S/A 5	Do Nothing		
Economic Damages					
AEP	1/AEP	Damage	Damage in Interval	Differnce in AEP	Annual Average Damage
4.5	0.222	0			
			796,260	0.182	**145,096**
25	0.04	1,592,519			
			4,256,713	0.02	**85,134**
50	0.02	6,920,907			
			10,689,658	0.010	**106,897**
100	0.01	14,458,409			
			26,698,327	0.0098	**261,644**
5000	0.0002	38,938,245			
			Total AAD		**598,771**
			PV over 50 years		**14,789,635**

Smithfield		S/A 5	Do Nothing		
Financial Damages					
AEP	1/AEP	Damage	Damage in Interval	Differnce in AEP	Annual Average Damage
4.5	0.222	0			
			940,805	0.182	**171,436**
25	0.04	1,881,610			
			5,031,167	0.02	**100,623**
50	0.02	8,180,724			
			12,576,956	0.01	**125,770**
100	0.01	16,973,187			
			31,224,283	0.0098	**305,998**
5000	0.0002	45,475,380			
			Total AAD		**703,826**
			PV over 50 years		**17,384,513**

Business Loss

Business loss using the Frontiers methodology excluding Additionality

Coton Hill					
Business Losses		**S/A 1**	**Do Nothing**		
AEP	**1/AEP**	**Loss**	**Loss in Interval**	**Difference in AEP**	**Annual Average Loss**
4.5	0.222	-			
			0.182	51,450	9,375
25	0.04	102,900			
			0.02	176,400	3,528
50	0.02	249,900			
			0.01	338,100	3,381
100	0.01	426,300			
			0.0098	470,400	4,610
5000	0.0002	514,500			
			Total Annual Average Loss		**20,894**
			PV over 50 years		**516,088**
			PV factor = 24.7		

Non residential Properties at Risk Coton Hill				***GVA mean Losses***	
Return Period	5000	100	50	25	4.5
Number of Properties	35	29	17	7	0
Gross Value Added (£)	514,500	426,300	249,900	102,900	-

Mean of 7 Employees; 20 days disruption;£105 GVA per employee per day

Table 8.1a Weekly pay (Median) - Gross (£) - For all employee jobs: United Kingdom, 2024 (Shropshire)

Source: Annual Survey of Hours and Earnings, Office for National Statistics.

Coleham		S/A 2	Do Nothing		
Business Losses					
AEP	1/AEP	Loss	Loss in Interval	Difference in AEP	Annual Average Loss
4.5	0.2222	-			
			0.182	95,550	17,411
25	0.0400	191,100			-
			0.020	345,450	6,909
50	0.0200	499,800			-
			0.010	558,600	5,586
100	0.0100	617,400			-
			0.0098	639,450	6,267
5000	0.0002	661,500			
			Total Annual Average Loss		**36,173**
			PV over 50 years		**893,472**
			PV factor = 24.7		

Non residential Properties at Risk Coleham				*GVA mean Losses*	
Return Period	5000	100	50	25	4.5
Number of Properties	45	42	34	13	0
Gross Value Added (£)	661,500	617,400	499,800	191,100	-

Mean of 7 Employees; 5.3 days disruption;£105 GVA per employee per day

Table 8.1a Weekly pay (Median) - Gross (£) - For all employee jobs: United Kingdom, 2024 (Shropshire)

Source: Annual Survey of Hours and Earnings, Office for National Statistics.

St Julians		S/A 4	Do Nothing		
Business Losses					
AEP	1/AEP	Loss	Loss in Interval	Difference in AEP	Annual Average Loss
4.5	0.22	-			
			0.182	44,100	8,036
25	0.04	88,200			
			0.02	154,350	3,087
50	0.02	220,500			
			0.01	301,350	3,014
100	0.01	382,200			
			0.0098	463,050	4,538
5000	0.0002	543,900			
			Total Annual Average Loss		**18,674**
			PV over 50 years		**461,257**
			PV factor = 24.7		

Non residential Properties at Risk St Julians				GVA mean Losses	
Return Period	5000	100	50	25	4.5
Number of Properties	37	26	15	6	0
Gross Value Added (£)	543,900	382,200	220,500	88,200	-

Mean of 7 Employees; 20 days disruption;£105 GVA per employee per day

Table 8.1a Weekly pay (Median) - Gross (£) - For all employee jobs: United Kingdom, 2024 (Shropshire)

Source: Annual Survey of Hours and Earnings, Office for National Statistics.

Smithfields					
Business Losses		**S/A 5**	**Do Nothing**		
AEP	**1/AEP**	**Loss**	**Loss in Interval**	**Difference in AEP**	**Annual Average Loss**
4.5	0.22	-			
			0.182	58,800	10,715
25	0.04	117,600			
			0.02	426,300	8,526
50	0.02	735,000			
			0.01	1,029,000	10,290
100	0.01	1,323,000			
			0.0098	1,565,550	15,342
5000	0.0002	1,808,100			
			Total Annual Average Loss		**44,873**
			PV over 50 years		**1,108,364**
			PV factor = 24.7		

Non residential Properties at Risk Smithfields				GVA mean Losses	
Return Period	5000	100	50	25	4.5
Number of Properties	123	90	50	8	0
Gross Value Added (£)	1,808,100	1,323,000	735,000	117,600	-

Upper Limit of Business Loss to flooded properties 20 days

Mean of 7 Employees; 20 days disruption;£105 GVA per employee per day

Table 8.1a Weekly pay (Median) - Gross (£) - For all employee jobs: United Kingdom, 2024 (Shropshire)

Source: Annual Survey of Hours and Earnings, Office for National Statistics.

The PV of Business Losses over a 50-year period are an underestimate as outage for extreme events (50 years and rarer) would be significantly more than the questionnaire responses to outage. However, these rarer events contribute significantly less than more frequent events to annual average losses.

Summary of Economic, Financial and Business Losses

Summary of Economic, Financial damages and estimated Business Loss						
Sub Area	Economic AAD	Financial AAD	Financial Additional AAD	Business Annual Average Loss	Plus Business Additionality at factor of 1.7	Grand TOTAL (Financial plus Business Loss)
Coton Hill	114,230	135,073	20,843	20,894	35,520	170,594
Coleham	272,289	316,991	44,702	36,173	61,494	378,485
St Julian's	58,514	87,634	29,120	18,674	31,746	119,380
Smithfield	598,771	703,826	105,056	44,873	76,284	780,111
TOTALS	**1,043,804**	**1,243,524**	**199,720**	**120,615**	**205,045**	**1,448,569**

Sub Area	Economic PVd	Financial PVd	Financial Additional PVd	Business Loss PVd	Plus Business Additionality at factor of 1.7	Grand TOTAL (Financial plus Business Loss)
Coton Hill	2,821,492	3,336,310	514,818	516,088	877,350	4,213,660
Coleham	6,725,533	7,829,677	1,104,144	893,472	1,518,902	9,348,579
St Julian's	1,445,298	2,164,552	719,254	461,257	784,138	2,948,689
Smithfield	14,789,635	17,384,513	2,594,878	1,108,364	1,884,220	19,268,733
TOTALS	**25,781,958**	**30,715,052**	**4,933,094**	**2,979,182**	**5,064,609**	**35,779,661**

Present Value of Damage/Loss

Difference between conventional appraisal Methodology and Financial damage + Business Loss

£9,997,703 assuming 20 days Outage and a median value of 7 employees/property

£7,465,399 assuming 10 days Outage and a median value of 7 employees/property

	Return Periods				
Number of properties	**5,000**	**100**	**50**	**25**	**Threshold (4.5)**
Coton Hill	35	29	17	7	0
Coleham	45	42	34	13	0
St Julian's	37	26	15	6	0
Smithfield	123	90	50	8	0
TOTAL	**205**	**158**	**99**	**27**	**0**

The £31.7 million financial damage plus Business loss to a maximum of 205 properties (5,000-year flood event) in the Arup flood modelling does NOT include properties with access issues.

An estimation of business losses through loss of access to the Arup listed businesses

An indication of the potential business loss through loss of access is estimated using the properties in the IA database registered as "Not at ground level" and coded non-residential or commercial in the Environment Agency National Receptor Dataset. This includes 85 properties with no flood damage in the 5,000-year event.

We do not have listings of ALL the premises in Shrewsbury town centre that will have access restrictions during flooding but we can apply properties defined as non-residential or commercial in the IA data but are not modelled as flooded even for the most extreme modelled events.

This approximation gives a Present Value of Business losses over 50 years of nearly half a million with an annual average loss of around £20,000 assuming 5 days outage because of access issues.

All Access restricted			**Do Nothing**		
Business Losses					
Annual Average Loss	**1/AEP**	**Loss**	**Loss in Interval**	**Difference in AEP**	**Annual Average Loss**
4.5	0.22222	-			
			64,313	0.18222	11,719
25	0.04	128,625			
			152,513	0.02	3,050
50	0.02	176,400			
			213,150	0.01	2,132
100	0.01	249,900			
			281,138	0.0098	2,755
5000	0.0002	312,375			
			Total Annual Average Loss		**19,656**
			PV over 50 years		**485,505**
			PV factor =24.7		

Non residential Properties at Access only at Risk				GVA mean Losses	
Return Period	5000	100	50	25	4.5
Coton Hill	5	4	1	1	0
Coleham	9	5	4	2	0
St Julian's	6	6	4	1	-
Smithfields	65	53	39	31	0
Total	**85**	**68**	**48**	**35**	**0**
Gross Value Added (£)	**312,375**	**249,900**	**176,400**	**128,625**	**-**
Access outage				***5***	***days***
Mean of 7 Employees; 5 days disruption;£105 GVA per employee per day					
Table 8.1a Weekly pay (Median) - Gross (£) - For all employee jobs: United Kingdom, 2024 (Shropshire)					
Source: Annual Survey of Hours and Earnings, Office for National Statistics.					

Overall summaries are presented in the following tables:

Sub Area	Economic PVd	Financial PVd	Financial Additional PVd	Business Loss PVd	Plus Business Additionality at factor of 1.7	Grand TOTAL (Financial plus Business Loss)
Coton Hill	2,821,492	3,336,310	514,818	516,088	877,350	4,213,660
Coleham	6,725,533	7,829,677	1,104,144	893,472	1,518,902	9,348,579
St Julian's	1,445,298	2,164,552	719,254	461,257	784,138	2,948,689
Smithfield	14,789,635	17,384,513	2,594,878	1,108,364	1,884,220	19,268,733
TOTALS	25,781,958	30,715,052	4,933,094	2,979,182	5,064,609	35,779,661

Difference between conventional appraisal Methodology and Financial damage + Business Loss = 9,997,703 assuming 20 days outage and a median value of 7 employees/property

Economic AAD	Financial AAD	Additional	Business	Additionality	Business Loss	Total AAD Financial	Additional %
Adjusted Arup	GeoSmart/ MCM	AAD	Annual Loss	1.7 factor	access only AAL	& Business Loss	from Arup
1,043,804	1,243,524	199,720	120,615	205,045	100,550	1,549,119	48%
Economic PVd	Financial PVd	Additional	Business	Additionality	Business Loss	Total PVd Financial	Additional %
Adjusted Arup	GeoSmart/ MCM	PVd	PV Loss	1.7 factor	access only PVL	& Business Loss	from Arup
25,781,958	30,715,052	4,933,094	2,979,182	5,064,609	2,483,574	38,263,235	48%

Assuming 20 days outage and a median value of 7 employees per property and GVA of £105 per person per day.

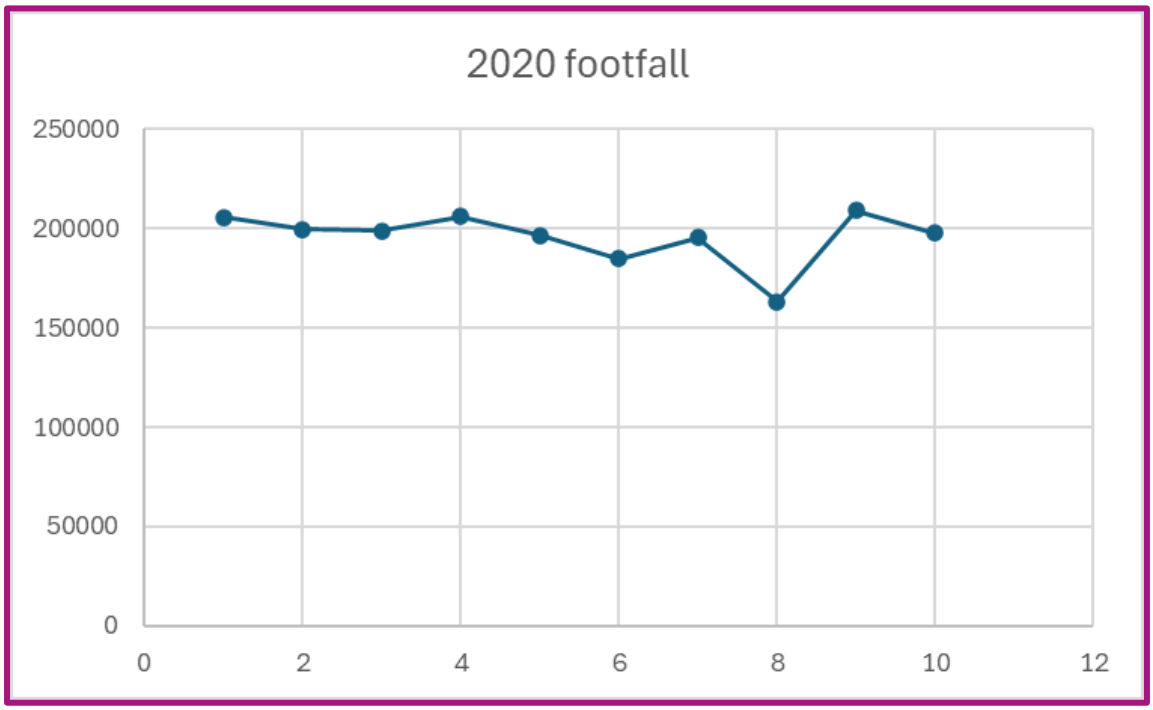
An alternative estimate of business loss to properties with no direct internal flooding uses the figures from the 2020 report by Shropshire oversight committee, where 209 properties not flooded reported loss of access and business loss (section 4.1). These losses equate to Annual Average Losses (NOT Annual losses from a single flood but based on integration under the loss probability curve – Figure 2)) of £100,000 and PVd over 50-years of £2.5million)

Reduction in sales during flood events

Another metric to consider is the reduction in vehicles and footfall during flood events. Data was extracted for floods in 2020 and 2022 courtesy of Shrewsbury BID.

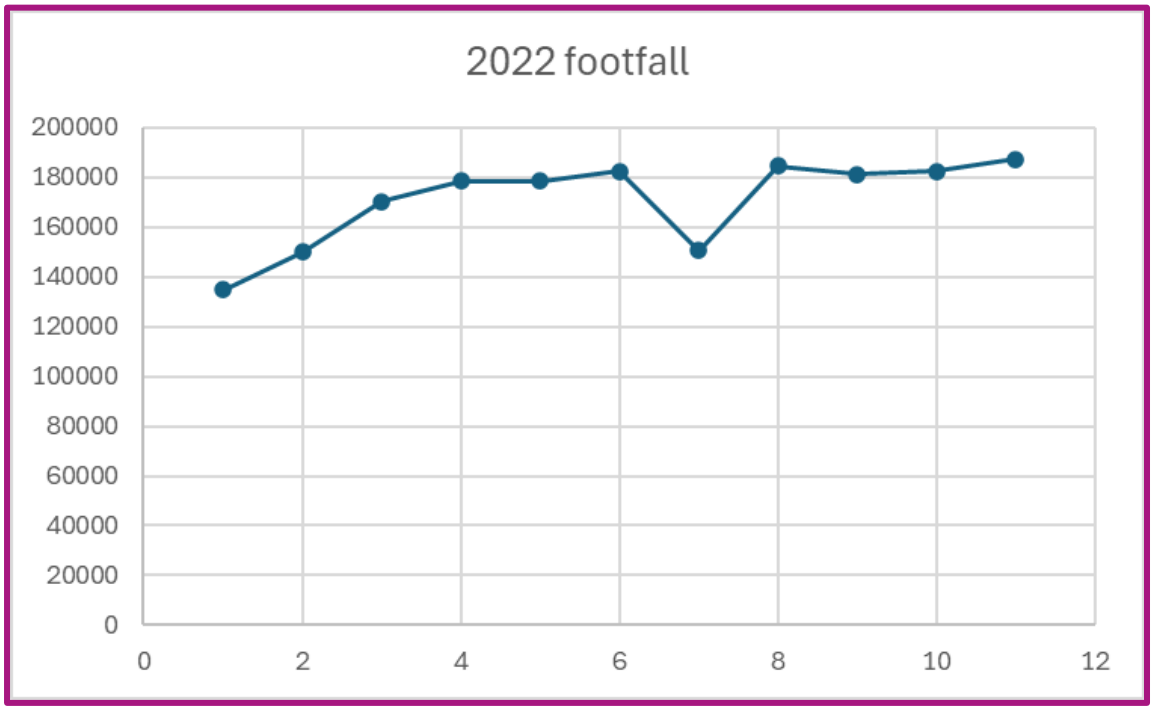
Figure 1 and 2 show the footfall (High Street/Pride Hill) at the peak of the flooding in 2020 and 2022 and the mean footfall for the weeks before and after, showing about a 20% reduction.

Figure 1. Drop in town centre footfall during 2020 floods



2020	
Average footfall week before and after	202318
Footfall in peak flood impact week	163037
Proportion	0.805845

Figure 2. Drop in town centre footfall during 2022 floods



2022	
Average footfall week before and after	183648
Footfall in peak flood impact week	150507
Proportion	0.819541

In the 2022 floods vehicle movements were two thirds of those seen in normal conditions. (BID data on High Street). Combining footfall and vehicle data it is estimated that during floods there is approximately 25% reduction in commercial activity in the town centre.

BID have compiled sales data for 2022/2023 and 2023 with a mean sales figure per year for these 3 years in the retail sector of £133,953,170 per year or £2,572,289 per week. Assuming a 25% drop in sales during flood weeks the sales losses would be £643,322.

Further Considerations

Review of the first draft of this report by the Environment Agency's economist Carlos Cuesta revealed the publication of two reports not consulted in GeoSmart's research:

- 2020 Flood Relief Business Grant data and Interdepartmental Business Register, a technical note by Carlos Cuesta, and
- Staying afloat: the impact of flooding on UK firms, Bank of England blog November 2024

These documents focus on the significant effects of flooding on business losses which go beyond the Frontiers techniques presented in the GeoSmart report.

The following key points need to be considered in any future work:

Future research into flood-related economic impacts would benefit from local business survey data, such as that collected for the Flood Recovery Grant. This information could refine assumptions in tools like Frontier's by better estimating disruption duration, which depends on factors like flood depth and business type.

Additionally, current methods underestimate losses by focusing solely on directly flooded businesses; indirectly affected firms—impacted by transport disruptions, footfall decline, and accessibility—must also be considered. Mapping road risks in areas like Shrewsbury illustrates how even dry businesses suffer from surrounding disruptions.

A more comprehensive analysis could include the duration and extent of transport impacts, informing either broader affected zones or multipliers for GVA loss estimates. The choice of metric matters too: salary-based GVA significantly underestimates impact. Using GVA per job better reflects true productivity, as shown by Shropshire's figures (£41k GVA/job vs. £28k salary). Loss estimates could then more accurately represent shutdowns (100% loss) and partial disruptions for operational but affected firms.

The Bank of England blog concludes:

The Bank of England's November 2024 blog post, "Staying afloat: the impact of flooding on UK firms," explores how climate-driven flooding is affecting UK businesses at both micro and macroeconomic levels.

Here are the key takeaways:

- Flood exposure is highly uneven: Certain regions and sectors—especially those drawn to cheaper land—face disproportionately high flood risks.
- Widespread business impact: Around 1% of UK firms and 2% of business premises have experienced flooding in the past 20 years, with the Bank of England's November 2024 blog post, "Staying afloat: the impact of flooding on UK firms," explores how climate-driven flooding is affecting UK businesses at both micro and macroeconomic levels.
- Flood exposure is highly uneven: Certain regions and sectors—especially those drawn to cheaper land—face disproportionately high flood risks.
- Widespread business impact: Around 1% of UK firms and 2% of business premises have experienced flooding in the past 20 years, with the figure rising to 6% in flood-prone areas like Yorkshire and the Humber.
- Economic consequences: Flooding negatively affects revenue, employment, and asset values across firms of all sizes.
- Data-driven insights: The study integrates firm-level corporate records with Ordnance Survey data and public flood maps to assess physical risk exposure.
- Policy implications: The findings underscore the need for targeted adaptation strategies and investment in flood resilience to mitigate long-term economic disruption

It is clear from these two reports that GVA as a method for evaluating business losses is vital in future flood alleviation strategies and the Frontiers method needs updating to encourage

higher losses. In tandem it is clear that wider business losses other than losses to businesses directly flooded will significantly enhance the importance of business losses as will the extent and duration of transport losses.

The GeoSmart report therefore underestimates the overall losses and cognisance of these strategic studies needs to be embedded in future analysis.

Of significance also to the allocation of public sector expenditure: In January 2025, the Chancellor of the Exchequer Rachel Reeves announced a review of the green book. The review's conclusions were published in June 2025 and are designed to improve the effectiveness of public sector appraisal. The Treasury will release an updated green book in early 2026 and is intending to increase flexibility in assessments of flood mitigation proposals for towns like Shrewsbury to recognise losses and damage of the nature reported in this analysis within overall cost-benefit analyses.

Discussion of likely impact of the new data on future findings:

- Duration of disruption: The duration is overestimated in the Frontier toolkit guidance. The available evidence from the properties that claimed the grant suggests the impact is much shorter. It looks like they opted for a 10 day and 20 days impact (low and upper bound). Whilst an average based on the grant data is higher than the 10 to 20 days, this assumption is reasonable given the average is likely skewed by a small number of properties claiming very long impacts.
- Number of employees: In our study we used the median of SMEs provided by a questionnaire with the sample size being 36, and we also informed employee numbers using an employment density approach, but we did not use the Interdepartmental Business Register (IDBR) dataset which had actual data on employees at the local business level. Future analysis should draw on this data to improve accuracy.
- Future analysis should include research on whether flooding has led to higher closures and / or vacancy rates in Shrewsbury and whether there's evidence that this leads to lower commercial property values.
- Our estimates are significantly under recorded as we were not able to interview non flooded properties albeit we attempted to use footfall to bolster indirect losses assessment.
- Additionality. We used the matrix provided in Frontiers assuming significant knock on effects both upstream and downstream in a thriving County town. The interpretation needs reviewing in future work.
- Use of Financial data. A further review is needed to assess how much to use financial data for evaluating public good. The objective is in part to quantify additional local benefits to assist with FDGiA. In this case local losses and damages are appropriate to encourage expenditure on local levies that directly benefits those at risk. For FDGiA economic depth damage data is mandatory. We included Financial losses to the business (not resource costs to the Nation) to determine the shortfall necessary for uptake of local contributions in the Partnership calculations.
- When considering the differences between approaches to loss estimation it is notable that the losses presented here are not HMT Green Book compliant when it comes to

requesting national funding. In relation to applying to local / regional funding where a place-based approach is acceptable, the additional damages/losses quantified in this report are not national damages or losses (those affecting the community not the nation, more akin to insurance losses). Further consideration of how best to factor in such assessments in national flood defence strategies is urgently needed.

- In future work consideration the Frontier method may be extended to account for closures, although this area is complex and there is also merit in considering instead vacancy rates. Businesses might well close but if another opens in the same location this is not (necessarily) a loss to Shrewsbury. In fact, a more productive and / or resilient business might open where a more vulnerable / less productive closes. Given the amount of flooding in Shrewsbury it can be assumed there is above average levels of resilience and awareness amongst businesses. However, SMEs dominate and these are less inclined to fund resilience and resistance measures and suffer considerably more than bigger corporates.

Shropshire Council[41] reported following 2020 flooding that Shrewsbury BID had conducted a survey of the business community that achieved 19% response rate from 950 businesses located in the town centre, with the following key findings (it is not known how representative the survey findings were):

- 68% of businesses reduced or operating or closed during the flooding period, suggesting that as many as 645 businesses may have been forced to close or reduce trading.
- Almost 10% of businesses did not expect to be up and running properly for a month or more
- 38% of businesses reported they had been flooded externally or internally
- Direct cost of damage ranged from £250 to £230,000, with a mean cost of £13,500
- 97% of businesses reported a loss of trade

[41] Shropshire Council. Impact of Flood Damage in Shropshire February/March 2020

Appendix E

Case Studies

The Salopian

Renowned for being the busiest wet pub in Shrewsbury, the Salopian has built a reputation as one of the go to spots in Shrewsbury to enjoy a drink, food and a range of live sport.

Situated in a prime location on Smithfield Road, the pub boasts several screens, multiple bars and an upstairs function room. However, the pub has not gone without its challenges.

Flooding has damaged the premises in four of the last five years, leaving disruption and havoc in its path. Flooding in February 2020, combined with the impact of COVID-19 left the premises closed for over fifteen months while repairs were undertaken.

Suffering approximately 40 cm of internal flooding during this event cost the business approximately £200,000 which was only partially covered by their insurance provider at the time. The business is now blacklisted and cannot obtain flood insurance or business interruption insurance as a result of frequent flooding.

Oliver Parry, the owner, notes flooding has been recorded at his property on over 50 separate occasions, including groundwater flooding affecting the cellar of his property, despite raising stock as high as possible and installing several sump and pump systems to quickly remove water from the premises. However, once the river level rises significantly, the cellar is inevitably flooded until river levels begin to fall.

The Salopian has achieved a partial mitigation of the flooding problems by acquiring the property next door and relocating the beer cellar to above ground level in the neighbouring property. This reduces their vulnerability to groundwater flooding but still leaves them vulnerable to river and surface water flooding, and access restrictions when closure of the highway occurs.

Oliver is thankful that flooding has affected his business during the quieter weekdays, as the cost of flooding to the business during a busy sport weekend would be catastrophic, resulting in huge losses to both his business and the wider town, resulting in an estimated loss of revenue of over £50,000.

The pub regularly checks the river levels via the DEFRA portal, but notes that the predictions are sometimes so wildly inaccurate that time and money has been wasted preparing the pub for a flood which never comes, due to problems with forecasts for the gauging station at Crew Green, which makes preparations for an upcoming flood all the more difficult.

Figure 1. Equipment at the Salopian is raised as high as possible in the newly acquired neighbouring property to reduce the impact of flooding

Lion and Pheasant

Located on Wyle Cop, the Lion and Pheasant is a popular place to stay for those visiting Shrewsbury that want to stay in the heart of the town. Featuring bedrooms, a restaurant and bar, the hotel is an ideal place to relax whilst staying on the banks of the Severn in a truly unique and historic building. The hotel experienced serious flooding in 2000, and four further serious floods in the last five years, most notably in 2021. Floods are caused by groundwater ingress, surface water flooding, and overtopping of the River Severn.

Not only is the Lion and Pheasant building fabric threatened by groundwater and river flooding, but also the hotel is threatened by extreme downpours, where the drainage network can no longer cope with the heavy rain The hotel was forced to close abruptly for several hours, one summer afternoon, due to a deluge of rain.

Unfortunately, the hotel has shut for much longer periods when the River Severn rises. In 2021, over 60 cm of water entered the hotel which took days of drying out before the hotel could re-open.

Publicity surrounding the floods deterred visitors and guests from travelling to the hotel for an extended period of time following the flood and resulted in cancelations of room and table bookings. Fortunately, the hotel kitchen is located on the first floor of this historic building.

Like many others, The Lion and Pheasant has implemented a plan to increase the resilience of the building and the business: new sumps to get water out of the cellars of the building as quickly as possible; reducing the time the building fabric is affected by water, procedures to move stock and furnishings upstairs when a flood warning is issued, and repairs, decoration and deep cleaning procedures following flooding.

However, the regular and increasing intensity of flooding events create a massive burden of additional costs and damage to the historic building fabric which threatens the sustainability of the business, the hotel is extremely vulnerable, mitigation is not affordable and insurances are no longer available to obtain.

Figure 2. The Lion and Pheasant attempt to clear floodwater from the building.

Barnabas Community Church

The Barnabas Centre has been part of the community for over thirty years, whilst also being an NHS blood bank and food bank, serving as a vital hub for the Coleham community with stunning views of the River Severn. With over 600 visitors weekly, the centre truly is a hub for the people of Shrewsbury.

The cost of flooding to the Barnabas Centre has been huge, with an insurance claim of over £300,000 for refurbishment following flooding in 2020, which included a massive £16,000 quoted cleaning cost (which was refused, and volunteers completed themselves) and £273,000 worth of damages, including a loss of power to the centre for several days. As a result, the Barnabas Centre is now blacklisted and can no longer claim following a flood. The centre is now extremely reliant on a self-assembled flood emergency fund, which they anticipate will have to be used in the event of another flood.

The centre was closed until June 2021 following the 2020 floods and lost over £30,000 in revenue from room rentals alone. The wider impact on the community can be felt, as the church services moved to the United Reformed Church at English Bridge during 2020. Refurbishment works were substantially hindered by the impact of the COVID-19 pandemic.

The Barnabas centre has invested heavily in flood resilience and resistance measures, including 90 cm flood barriers on all entrances to prevent water ingress to the building. A monumental effort is required from all who volunteer at the centre to install the flood barriers and begin moving equipment to higher levels of the building on receipt of a flood warning. The barriers cost an estimated £25,000 but do not protect against the hidden risk of groundwater flooding, which has been noted to flood the lower levels of the centre on several occasions. Further measures such as airbrick covers have also been installed to reduce the likelihood of water ingress to the building.

The food bank store is now located in a new outbuilding, raised as high as possible to prevent damage to stock and items can be moved on receipt of a flood warning within two hours. The centre is heavily reliant on accurate and timely warnings, to ensure the wider community has access to a food bank whilst minimising damages to any stock from floodwater.

Figure 3. Five communities in Shrewsbury that suffer significant flood losses, shown along with Environment Agency flood zones

Chase Car Centre

Another business located on Smithfield Road, Chase Car Centre provides vehicle services and MOTs for vehicles in the heart of Shrewsbury. The garage has recorded flooding in 2000, 2020, 2021, 2022, 2023 and 2024, including a substantial closure of 14 weeks in 2020. The remaining flood events kept the business closed for a combined 13 days between 2021 and 2024.

Mark Edwards noted that groundwater flooding is the key warning sign prior to a large river flood event, with substantial flooding of over a metre in lowered areas in 2020. Where groundwater joins with river flooding in the garage, significant internal flooding is marked on one of the doors as a stark reminder of historic flood events including 2000 and 2022. Mark estimates that the cost of damages to his business were between £150,000 to £180,000 following the 2020 floods.

Following an insurance claim in 2020 of over £150,000 the excess has now risen substantially – to the point that no claims have been made since due to the eyewatering £30,000 excess attached to their most recent flood insurance policy.

In addition to this, Mark estimates that the cost of installing flood resilience measures has totalled approximately £15,000 including a new lift to raise equipment above floodwater, sump and pump systems as well as raising electrical wiring to prevent further damages in the event of a flood. Whilst a PFR grant was provided, the vast majority of these costs were covered by the business.

Mark has discussed that the closures due to flooding have affected future trade, as repeat MOTs and services are lost during times of flooding, including the flooding and clean up time of Smithfield Road.

News of flooding in Shrewsbury has also led to the cancellation of appointments as customers are reluctant to take the risk of travelling into the town centre, further increasing the loss of revenue when the town centre hasn't experienced any flooding.

Mark has also noted that the gauging stations are unreliable and so preparations for flooding are done from experience and notes the delayed clean up response on Smithfield Road has damaged his business once floodwater has receded.

Venue 7

Located on the banks of the Severn, Venue 7 boasts fantastic views of the river, with a large outdoor decking area for visitors to enjoy whilst out for a drink. Venue 7 regularly takes large bookings and parties, making it the ideal attraction during the summer months.

The bar was refurbished in 2014, incorporating several resilient measures including non-return valves, raised electrics and new hard flooring to reduce the impact of flooding. Anthony notes that he would like to install formal flood barriers on the entrances to the property in the likely event of flooding in the years to come. He is also signed up to the EA's flood warnings and has an informal flood plan in place to raise stock and equipment as high as possible.

These measures were critical in reducing the impact of flooding during January 2021, protecting the businesses and reducing the cost of flooding. However, despite the measures implemented Venue 7 remained closed for up to three weeks after the January flood, drying out and clearing floodwater. Anthony now notes his business is no longer insured for flooding, which was withdrawn around 2017. Despite having insurance, the excess on his previous policy was so high that he never claimed.

Anthony also noted that there is a lag where people return to Shrewsbury following a flood event, where Venue 7 experiences a quieter spell even once floodwaters recede, further exacerbating the cost of flooding to the business.

Figure 4. The car park and decking of Venue 7, located on the banks of the Severn at Shrewsbury.

Sabrina Boat Tours

Visitors to Shrewsbury can enjoy a relaxing boat tour along the River Severn and enjoy the peace of the river. However, whilst the offices of Sabrina remain flood free, the frequent high river levels can drastically disrupt the operation of the boat tours, which desperately depends on calm river levels and good weather.

Dilwyn, who is responsible for the operation of the tours knows all too well how the river can make the summer season and subsequent income. Last summer, Dilwyn lost 28 days of touring due to high river levels alone, where he estimates 30 days of lost trade could lead to losses of up to £110,000, where they cater for up to 300 people per day in the peak summer months. In June alone, the Sabrina cancelled 20 days leading to a loss of earnings up to £60,000.

The losses are exacerbated further when insurance is considered – the Sabrina cannot claim for business interruption unless the business is interrupted for 18 consecutive days, which is an extreme rarity. The Sabrina has also had to claim on damages to the boats due to the high river levels, including a destroyed pontoon and a damaged engine, which cost over £3,500 to repair.

The Sabrina also noted that even when river levels are safe, trade is severly disrupted when the media reports flooding in the Shrewsbury area, resulting in a huge decline in business in the early spring months. Dilwyn noted that the once popular festive parties and tours are now no longer feasible, as the weather and river levels are too unpredictable and regularly too high to run safely.

Figure 5. The Sabrina boat tours are no stranger the impacts of flooding from the River Severn

Flood Risk Analysis

As part of the case study, each Site was assessed using GeoSmart's FloodSmart Analytics dashboard to provide an indication of the key flood risks associated with each property, both now and in the future.

Flood risk may originate from different sources, each subject to variations in likelihood, severity, climate change impacts and mitigation requirements. A score out of 100 has been provided for each flood source based on the frequency, depth, duration and cost of flood damage for a typical property. Fluvial, pluvial, tidal and groundwater flood sources are considered independently and as an aggregated risk.

A score of zero indicates negligible risk and a score of one hundred is very high indicating insurance may be difficult or expensive to obtain (A risk score of 100 does not imply that the site is entirely flooded or that the structure is a total loss). The risk score in 30 years time under a high emissions climate change scenario (UKCP18, RCP8.5) is presented to give an indication of potential future risk. The definition of each flood risk rating can be found below.

Flood Risk Index Rating	Flood Risk Index Score Banding	Definition
Very High Risk	91-100	Flood risk has been identified which presents a very high risk. This classification relates to very frequent flood events and/or very deep flood depths in the flood models analysed.
High Risk	71-90	Flood risk has been identified which presents a high risk. This classification relates to very frequent flood events and/or deep flood depths in the flood models analysed.
Medium Risk	51-70	Flood risk has been identified which presents a medium risk. This classification relates to frequent flood events and/or moderate flood depths in the flood models analysed.
Low Risk	31-50	Flood risk has been identified which presents a low risk. This classification relates to infrequent flood events and/or shallow flood depths in the flood models analysed.
Very Low Risk	1 – 30	Flood risk has been identified which presents a very low risk. This classification relates to very infrequent flood events and/or very shallow flood depths in the flood models analysed.
Negligible Risk	0	No flood risk has been identified. There may still be some risk but it is likely to be inconsequential and is not represented in the flood models analysed.

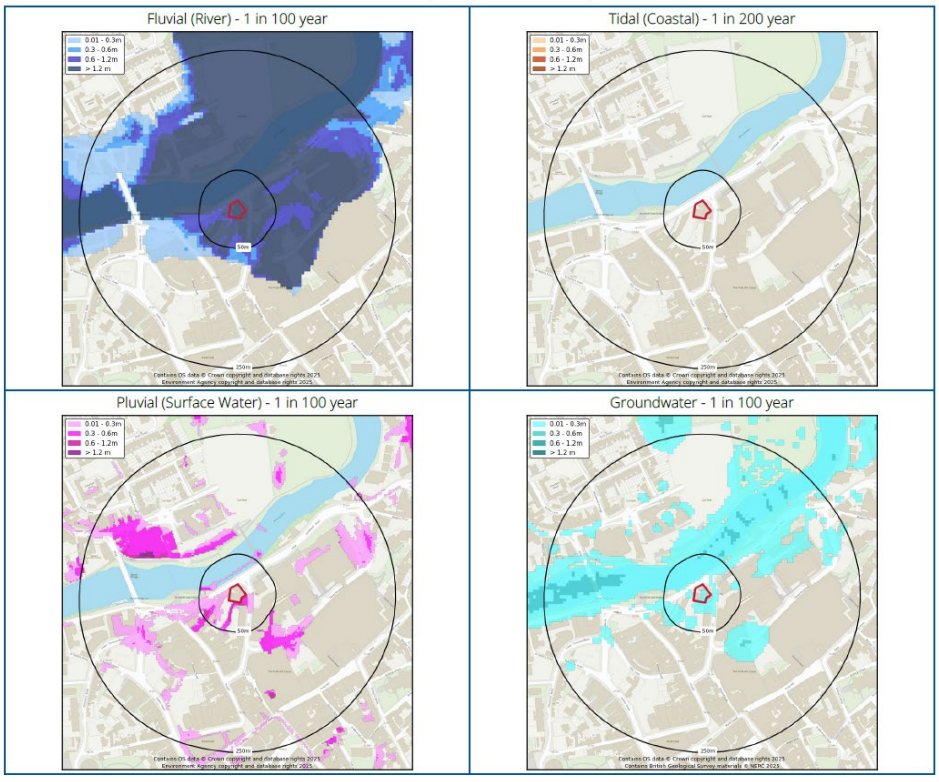
The Salopian

The Salopian has a combined defended score of 100, indicating a Very High overall risk. The screening scores for other sources are identified in the table below. It should be noted that despite the screening assessment identified a Very Low risk of groundwater flooding this does not take into account the presence of a lower ground floor or basement. Given the historical groundwater flooding at the Site and cellar, the risk is likely to be higher. Undefended extents are shown in the Figure below, identifying a risk from groundwater, surface water and fluvial sources.

	Fluvial (Rivers)	Surface water	Groundwater*	Combined
Screening Score	100	4	19	100
Screening Score (2050s)	100	6	29	100

*Groundwater screening score does not consider the presence of a lower ground floor or basement and as such the risk of groundwater flooding is likely to be increased.

Flood Depths (Undefended)



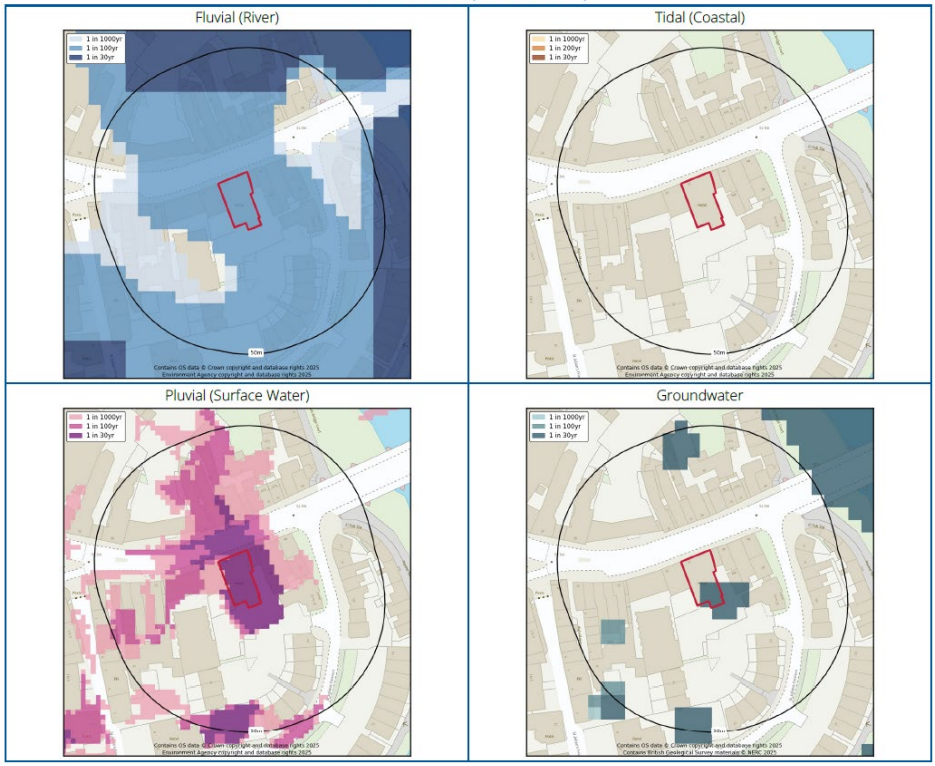
A review of national datasets has also been undertaken to further understand the risk of flooding to the Site. The Site is also located within fluvial Flood Zone 3, with a high probability of flooding from the River Severn. The EA's Risk of Flooding from Rivers and Seas dataset (Figure below) which considers the benefit of defences identifies the Site at Medium risk of flooding during the present day, increasing to High during a future climate change scenario (2050s epoch).

The Lion and Pheasant

The Lion and Pheasant has a combined defended score of 100, indicating a Very High overall risk. The screening scores for other sources are identified in the table below. Whilst the risk from rivers is lower than the Salopian the Site has a Very High surface water risk combined with a Low groundwater risk score and a Medium risk score from rivers, increasing to High during a future climate change scenario.

	Fluvial (Rivers)	Surface water (Pluvial)	Groundwater	Combined
Screening Score	62	99	36	100
Screening Score (2050s)	73	100	48	100

Flood Extents (Undefended)



The Site is also located within fluvial Flood Zone 3, with a High probability of flooding from the River Severn. The EA's Risk of Flooding from Rivers and Seas dataset, which considers the benefit of defences identifies the Site at Medium risk of flooding during the present day, again increasing to High during a future climate change scenario.

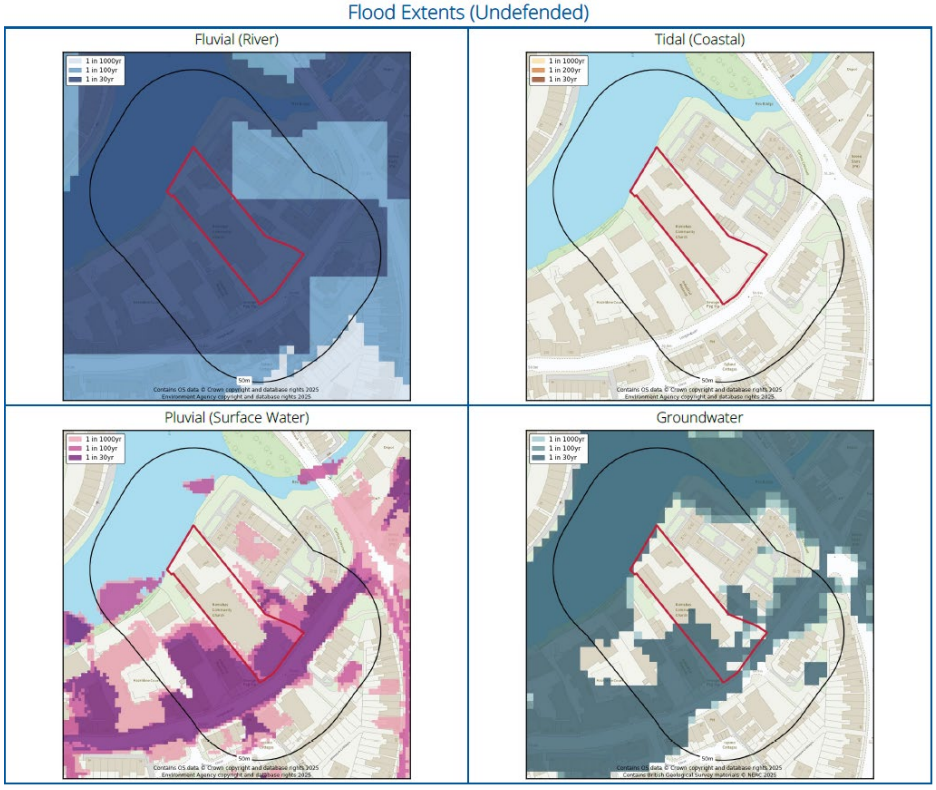
The EA's Risk of Flooding from Surface Water (RoFSW) identifies the Site at High risk of pluvial flooding, where flood depths greater than 0.30m are anticipated during a High risk event to the rear of the hotel. Given the Site's historical internal surface water flooding, the modelling appears to be an accurate representation of a significant flood risk from surface water.

Barnabas Community Church

The Barnabas Community Church also has a combined defended risk score of 100, indicating a Very High risk. The risk scores in the table below also identify a Low risk of pluvial flooding, increasing to Medium during a future climate change event. The risk of groundwater flooding is Very Low, although occupants of the Site note groundwater ingress at the Site during high river events.

	Fluvial (Rivers)	Surface water (Pluvial)	Groundwater	Combined
Screening Score	100	50	13	100
Screening Score (2050s)	100	54	20	100

Flood Extents (Undefended)



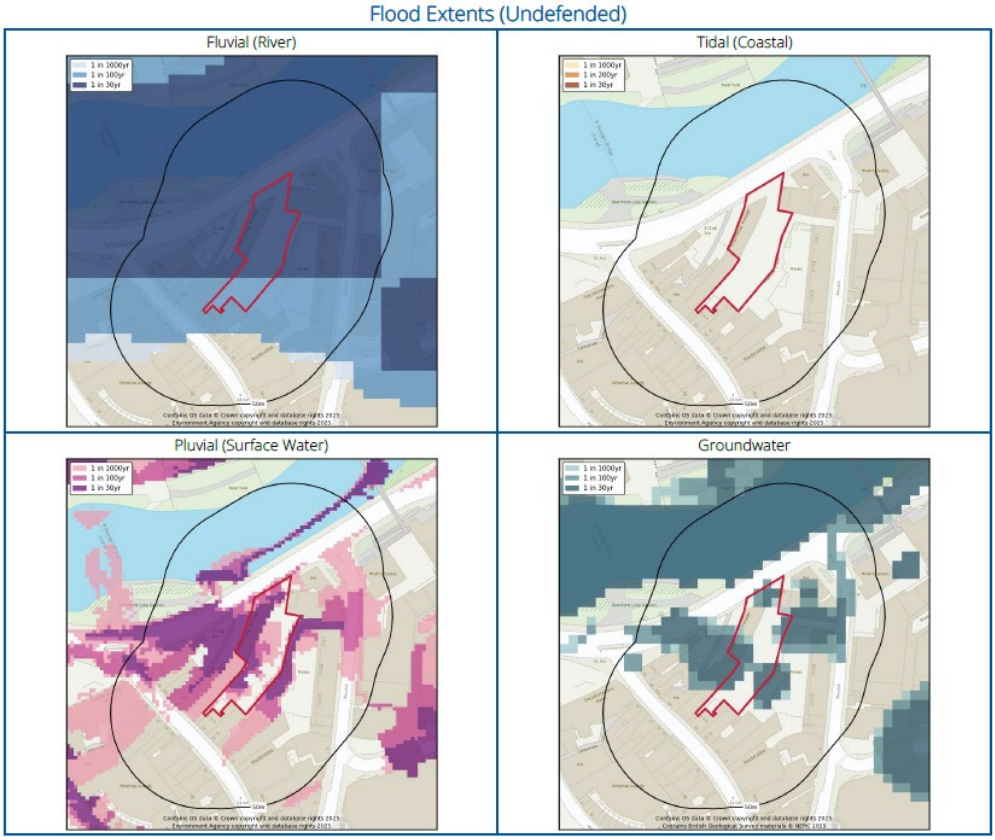
The Site is also located within fluvial Flood Zone 3, with a High probability of flooding from the River Severn. The EA's Risk of Flooding from Rivers and Seas dataset identifies the Site at High risk of flooding during a present day and future climate change event where depths range between 0.9 and 1.20 m during a present-day Low risk event.

The EA's Risk of Flooding from Surface Water (RoFSW) identifies the Site at Very Low to High risk of pluvial flooding, where flood depths up to 0.20 m are anticipated in the front car park during a High risk surface water event.

Chase Car Centre

Chase Car Centre also has a combined defended score of 100, with a Very High risk of fluvial flooding from the River Severn. During the present day and a 2050s climate change event, there is a Medium risk of flooding from surface water. Flood risk from groundwater is considered to be Very Low during a present day and climate change event. It is likely that risk of groundwater is higher than the screening report, due to multiple recorded instances of groundwater flooding at the Site according to the Site users.

	Fluvial (Rivers)	Surface water (Pluvial)	Groundwater	Combined
Screening Score	100	58	20	100
Screening Score (2050s)	100	64	30	100



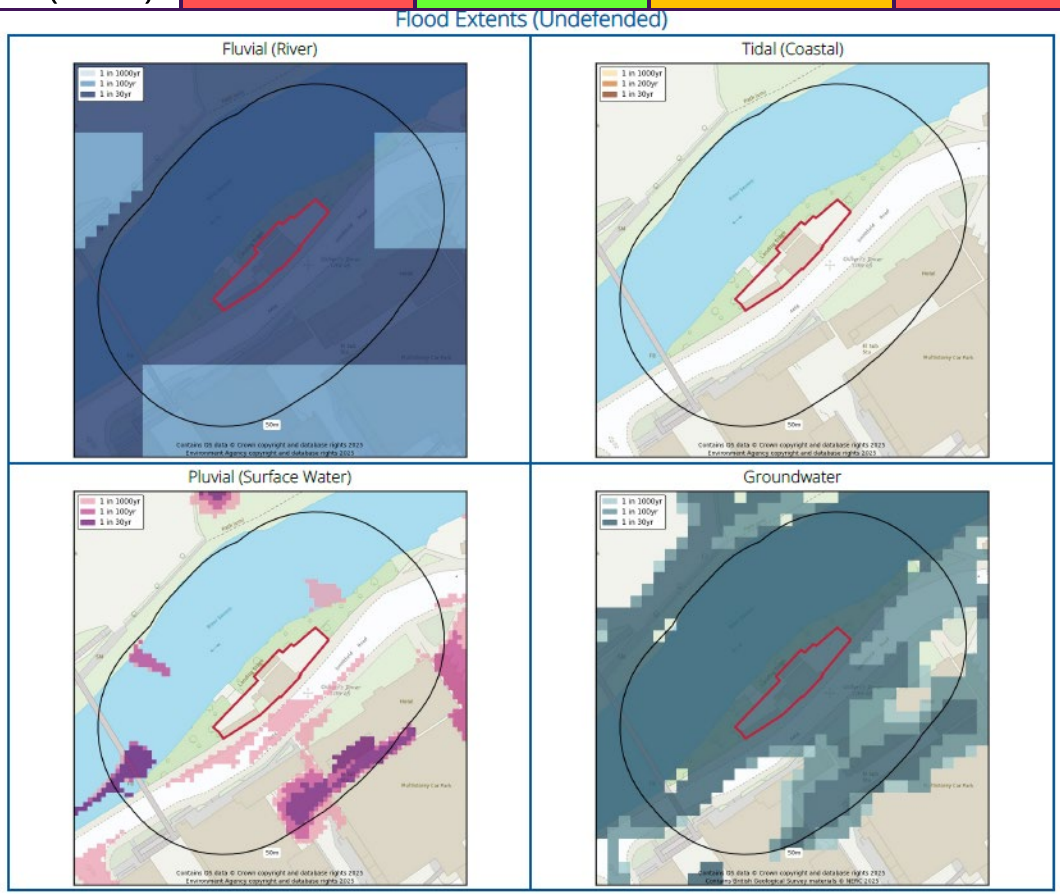
Situated within Flood Zone 3, the Site has a High probability of flooding according to the EA. The EA's Risk of Flooding from Rivers and Seas dataset identifies the Site at Medium risk of flooding during a present-day event, with the risk increasing to High during a future 2050s event.

The Site is also mapped as Very Low to High risk of flooding according to the EA's Risk of Flooding from Surface Water, where the High risk is generally located in the northwest of the Site and the location of the main garage.

Venue 7

Located further up Smithfield Road and on the banks of the Severn, the risk of flooding is dominated by fluvial and groundwater sources, with a Negligible risk of flooding from surface water during the present day and future climate change event.

	Fluvial (Rivers)	Surface water (Pluvial)	Groundwater	Combined
Screening Score	100	0	46	100
Screening Score (2050s)	100	0	54	100



Situated within Flood Zone 3, the Site has a High probability of flooding according to the EA. The EA's Risk of Flooding from Rivers and Seas dataset identifies the Site at Medium to High risk of flooding during a present-day event, with the risk increasing to High during a future 2050s event.

Technical Summary of Findings

The screening scores for the sites used as case studies for the cost of flooding to non-residential buildings are combined in the table below. The scores indicate all Sites are at Very High combined risk of flooding from several sources, including fluvial, groundwater and surface water flooding.

Business	Screening Score	Fluvial (Rivers)	Surface water	Groundwater*	Combined
Salopian	Present Day	100	4	19	100
	2050s	100	6	29	100
Lion and Pheasant	Present Day	62	99	36	100
	2050s	73	100	48	100
Barnabas Community Centre	Present Day	100	50	13	100
	2050s	100	54	20	100
Chase Car Centre	Present Day	100	58	20	100
	2050s	100	64	30	100
Venue 7	Present Day	100	0	46	100
	2050s	100	0	54	100

*Please note that groundwater screening scores do not account for the presence of a basement or lower ground floor, and as such these scores are representative of groundwater flooding at the surface only. The risks for buried services and basements are likely to be substantially higher.