Bembridge Section 19 Flood Investigation

Final Report

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Contract

This report describes work commissioned by James Brewer, on behalf of Isle of Wight Council, by an email dated 07 September 2021. Isle of Wight Council's representative for the contract was James Brewer. Emma Elwood and Melody Burgess of JBA Consulting carried out this work.

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Purpose

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Acknowledgements

We would like to thank the Isle of Wight Council, Southern Water, Island Roads, the Environment Agency. We would also like to thank the wider community for their contributions to the investigation.

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Executive summary

Background

Following the flooding in Bembridge in June 2021, Isle of Wight Council (IWC) as the Lead Local Flood Authority (LLFA) is undertaking a formal flood investigation under Section 19 of the Flood and Water Management Act 2010.

It is a statutory requirement for LLFAs to investigate flooding to the extent that it considers it necessary or appropriate.

Bembridge is a large village located approximately 8km from Ryde on the eastern coast of Isle of Wight. The smaller settlement of Hillway is also within the Parish of Bembridge. There are no watercourses passing through the village of Bembridge, except for a small ditch inland at Steyne Road. At Hillway, there is an ordinary watercourse which flows in a northerly direction through the village, passing under Hillway Road and Sandown Road (B3395). There are no designated Main Rivers within the study area. The Isle of Wight's largest river, the Eastern Yar (a Main River), flows around the west of Bembridge, joining the Solent at Bembridge harbour, at the north of the village.

The flooding that occurred in Bembridge on 29 June 2021 caused internal flooding to at least 12 properties and therefore fulfils the criteria for a Section 19 investigation. IWC has appointed JBA Consulting to undertake this investigation on its behalf.

For more information see Section 1.

Stakeholder engagement

As part of the Section 19 investigation, we engaged with local stakeholders in Bembridge, including residents, community representatives such as the parish council and other Risk Management Authorities.

The objectives of engagement are to:

- Gather facts, opinions and data to aid the understanding of the investigation
- Enable the involvement and buy-in of the community in the investigation
- Disseminate the findings of the investigation to the community

More information on how we engaged with stakeholders is included in Section 2.

Catchment characteristics

Section 3 describes the watercourses, urban drainage network, topography and geology of Bembridge.

Long-term flood risk information

Section 4 summarises the existing long-term flood risk information on the risk of flooding from rivers, surface water and groundwater. There are limited reports of historic flooding in Bembridge. However, flooding on Bembridge High Street and Steyne Road has occurred multiple times due to surface water runoff and drainage exceedance. The area around Solent Landing and Station Road in the north of the village is also at risk at tidal flooding in a 0.1% annual probability event.

Flood Risk Management

Responsibility for flood risk can be divided into "flood risk management" and "emergency response". Section 5.1 describes the roles and responsibilities of the various bodies involved in flood management and emergency response. Section 5.3 describes the existing flood risk management activities undertaken, including flood warnings; community resilience; and planning and development control activities.

For more information see Section 0.

Hydrological analysis

Flooding in Bembridge was reported on three separate occasions in June 2021 and on a further five separate occasions in July 2021. We assessed rainfall data on these dates against the reported flood incidents and identified flood incidents to take forward for further analysis. The rainfall events of 28- 29 June 2021 were taken forward for further investigation based on this analysis.

The storm event that affected Bembridge on 28 – 29 June was estimated to have between a 5% and 2% (1 in 20 to 1 in 50) probability of occurring in any one year. This rainfall event is therefore considered to be an extreme summer storm event, characterised by a large volume of rainfall falling within a short time with the potential to overwhelm the design capacity of the receiving networks.

For more information see Section 6.

Incident response

Island Roads responded to the flood event on 28 - 29 June under the Private Finance Initiative (PFI) contract with Isle of Wight Council and attended the flooding at High Street. Advice was given by the Fire and Rescue service over the phone, although they did not attend. A timeline of the incident response is included in Table 7-1.

For more information see Section 7.

Source-pathway-receptor analysis

The sources, pathways and receptors of flooding on the 28 – 29 June 2021 event were as follows:

- Sources – extreme rainfall, groundwater (Hillway only), exceedance of sewer and highway drainage capacity and blockages within sub surface drainage systems (High Street)
- Pathways – overland flow, surface water drainage exceedance
- Receptors – Confirmed internal flooding to approximately 10 residential properties and two commercial properties. One property owner, affected by flood events on 28 - 29 June and 27 July 2021, has been housed in alternative accommodation for over 6 months. Flooding occurred on the highway, although no formal road closures were instigated by Island Roads.

For more information see Section 8.

Capacity review

As outlined in Section 6, the rainfall event of 28 to 29 June 2021 had an annual probability of between 5% and 2% (between a 1 in 50 and a 1 in 20 year event) which is considered to be an extreme rainfall event. Southern Water reported potential capacity issues on the sewer network during the event, which across the majority of Bembridge comprises of a combined sewer, accepting both surface and foul water. Data available on the Southern Water website shows evidence of a prolonged combined sewer overflow discharge on this date at Bembridge Point and Lane End. It can therefore be concluded that hydraulic overload of the combined sewer system took place during the event. This is supported by reports from local residents of foul water flooding.

Discussion, appraisal and recommendations

In this section, we discuss in more detail some of the aspects of flood risk management in the Isle of Wight, and we consider potential options to mitigate flood risk and reduce damages caused by flooding.

We undertook a high-level option appraisal focussing on the potential benefits, practicality and viability of each option. We carried out a multi-criteria analysis to compare each option which included consideration of a range of different factors, for example the potential contribution towards reducing flood risk to property, people and communities.

For more information see Section 10 and Appendix C.

Conclusions

A series of recommended actions for the Risk Management Authorities and stakeholder organisations are presented below.

For more information on options, recommendations and conclusions see Section 11.

Recommendation	Organisations(s) responsible	Multi-criteria analysis score	Timescale
Surface Water Management Plan	Southern Water/ Highway Authority/ LLFA	7	1-5 years
Property Flood Resilience scheme	EA/LLFA/ Residents	7	<1 year
Appraise the feasibility of providing upstream flood attenuation	Landowner/ LLFA/ Highway Authority	7	1-5 years
Extension of existing drainage networks upstream at High Street/Mill Road	Highway Authority	6	Long term aim

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Abbreviations

AEP	Annual Exceedance Probability
AOD	Above Ordnance Datum
BGS	British Geological Society
CCTV	Closed Circuit Television
DTM	Digital Terrain Model
EA	Environment Agency
FEH	Flood Estimation Handbook
GIS	Geographic Information Systems
IWC	Isle of Wight Council
JBA	Jeremy Benn Associates
LiDAR	Light Detection and Ranging
LLFA	Lead Local Flood Authority
LTA	Long Term Average
mAOD	Meters Above Ordinance Datum
PFR	Property Flood Resilience
RMA	Risk Management Authority
RoFSW	Risk of Flooding from Surface Water (Environment Agency mapping)
SWMP	Surface Water Management Plan
WASC	Water and Sewerage Company
WTW	Waste Treatment Works

1 Introduction

1.1 Background to investigation

Flooding occurred to properties and businesses in Bembridge in June 2021. In its role as the Lead Local Flood Authority (LLFA), the Isle of Wight Council (IWC) has commissioned JBA to undertake a formal flood investigation under Section 19 of the Flood and Water Management Act 2010[1].

The Council has outlined its criteria for undertaking a Section 19 investigation in its **Flood Investigation Protocol**[2].

- *Where there is ambiguity surrounding the source or responsibility of a flood incident;*
- *Where internal flooding of one property has been experienced on more than one occasion; OR*
- *Where internal flooding of a group of properties has been experienced during a single flood incident; OR*
- *Where flooding resulted in disruption of one or more items of critical infrastructure; OR*
- *Where a single flood incident resulted in flooding that affects vulnerable individuals; OR*
- *Where there is risk to life as a result of flooding.*

The flooding that occurred in Bembridge caused internal flooding to at least 12 properties, according to information received by the Council.

Flooding was reported through late June into July 2021 throughout Bembridge Parish. The focus of this investigation is to establish a robust timeline of events, using multiple sources of information to determine when flooding occurred that would meet the criteria for a section 19 investigation.

It also seeks to understand the sources of flooding and how that impacted the Parish of Bembridge as well as any strategic issues that could lead to recommendations to reduce flooding in Bembridge in the future.

1.2 Site location

Bembridge is a large village located approximately 8km from Ryde on the eastern coast of Isle of Wight. During June and July 2021, flooding was reported throughout Bembridge Parish, with reports from Solent Landing at the northern coast to Hillway around 2.2 km to the south. To aid reporting, the study area has been divided into four areas:

1 High Street
2 Solent Landing/ Station Road area including Harbour Strand and Beach Road
3 Steyne Road/ Lane End Road
4 Hillway and Long Barn (outside of the village centre)

1 Flood and Water Management Act 2010 Section 19 (accessed 17 May 2021): https://www.legislation.gov.uk/ukpga/2010/29/section/19

2 Isle of Wight Council Flood Investigation Protocol: https://www.iow.gov.uk/azservices/documents/2821-Flood-Investigation-Protocol-March-2015.pdf

1.3 Data collection

A wide range of data has been collected and assessed to inform the Section 19 investigation. This has been used to understand the causes of flooding in Bembridge and to establish the context of the area. This includes the following:

- Open-source data from GOV.UK
- Photographs from a site visit on 03 December 2021
- Hydrometric data
- Reports from residents
- Call logs from other organisations such as Fire and Rescue; Island Roads and Southern Water
- Information from authorities on drainage infrastructure, such as highways and water companies.
- Other data such as photographs newspaper articles and social media posts.

2 Stakeholder engagement

We engaged with local stakeholders, including residents (where contact details have been provided), Bembridge Parish Council, Council Members and Risk Management Authority (RMA) partners.

The objectives of engagement are to:

- Gather facts, opinions and data to aid the understanding of the investigation
- Enable the involvement and buy-in of the community in the investigation
- Provide more technical debrief with RMA and operational partners
- Disseminate the findings of the investigation to the community
- A list of key stakeholders and how we engaged with them is given in

Table 2-1. The engagement terminology is taken from Environment Agency's 'Working with Others' (2013) methodology:

- Inform - provide information
- Consult - receive, listen, understand and feedback
- Involve - decide together
- Collaborate - act together
- Empower - support independent action

Table 2-1: Key stakeholders

Role	Organisation	How to engage	Type of engagement
Residents	N/A	Consult	Online questionnaire, correspondence
Parish/Town Council	Bembridge Parish Council	Consult	Invitation to contribute, correspondence
Water and Sewerage Company (WASC)	Southern Water	Involve	Invitation to contribute, correspondence, data provision
Highways Authority	Isle of Wight Council / Island Roads	Involve	Invitation to contribute, correspondence, data provision
Environment Agency	Environment Agency	Involve	Data provision
LLFA	Isle of Wight Council	Involve	Invitation to contribute, correspondence, site visit, data provision
Council Members	Isle of Wight Council	Consult	Invitation to contribute, correspondence
Emergency Planning and Business Continuity	Emergency Management IWC	Consult	Invitation to comment on draft report

3 Catchment characteristics

3.1 Topography

The elevation of Bembridge Parish ranges from around -1 mAOD to 80 mAOD, shown in Figure 3-1. The highest points can be found at the southern end of the village centre and at the southern boundary of the parish, with these high points separated by a dip in the topography at Hillway. The lowest lying ground is at Brading Marshes (forming the floodplain of the Eastern Yar) and Bembridge harbour to the north of the study area.

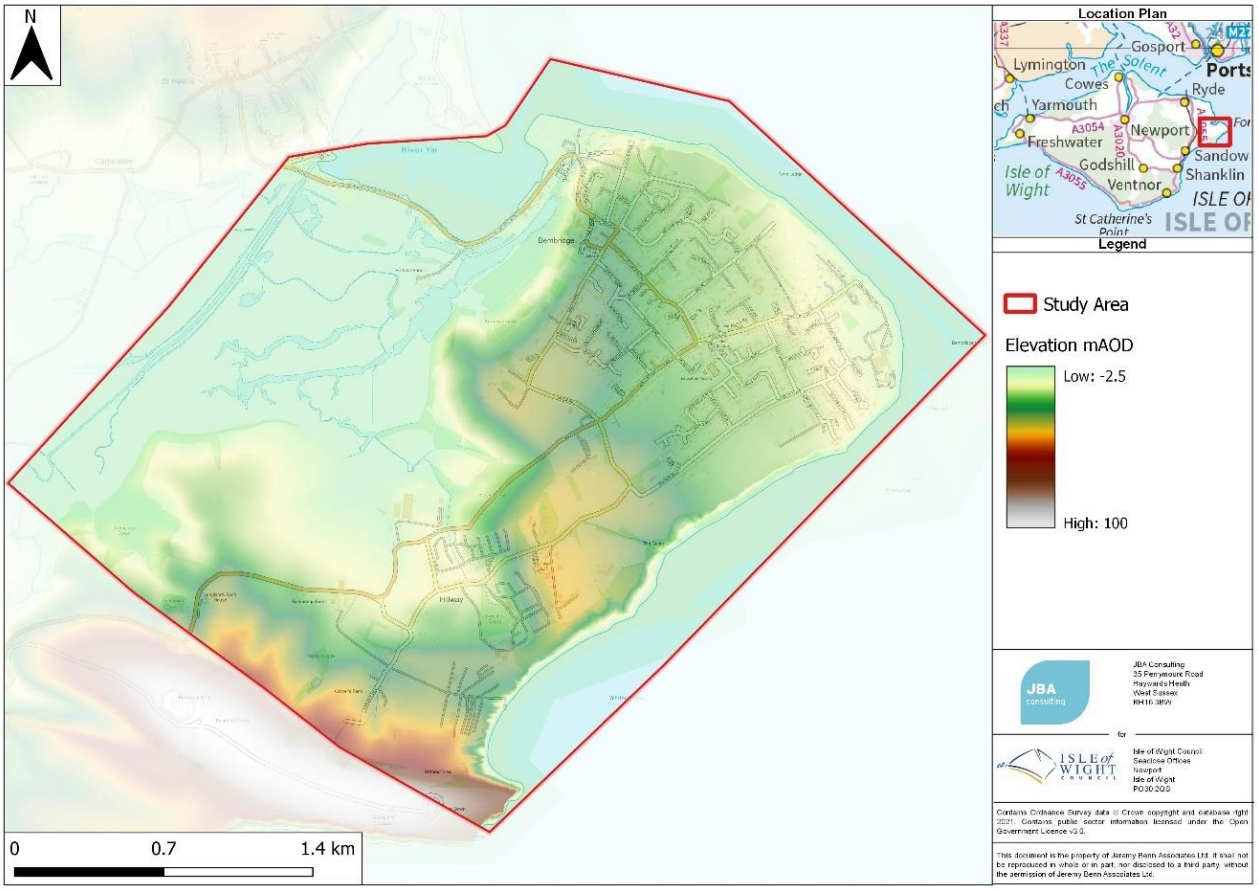

Figure 3-1: The topography of Bembridge

3.2 Geology and soils

The British Geological Survey (BGS) 50K mapping included in Figure 3-2**Error! Reference source not found.** shows the Bembridge Limestone Formation surrounding the coastline from north to south. Most of Bembridge is underlain by the Bembridge Marls defined by the British Geological Survey as *clays and silts with occasional thin sands, lime-mudstones and limestones, contains a low diversity brackish and freshwater molluscan fauna often concentrated in seams.* Borehole information from the BGS indicates that, in the centre of the village, wells have been dug through the impermeable Marls to the limestone underneath. Around the coast, limestones are present at the surface.

To the southwest of Hillway there are thinner bands of various rock strata transitioning to the Portsdown Chalk Formation, caused by folding of the chalk layers. There is a variety of superficial deposits in Bembridge Parish, as seen in Figure 3-3. The village centre, apart from the areas in the south west of the village, is underlain with sandy gravels of the Bembridge raised beach member

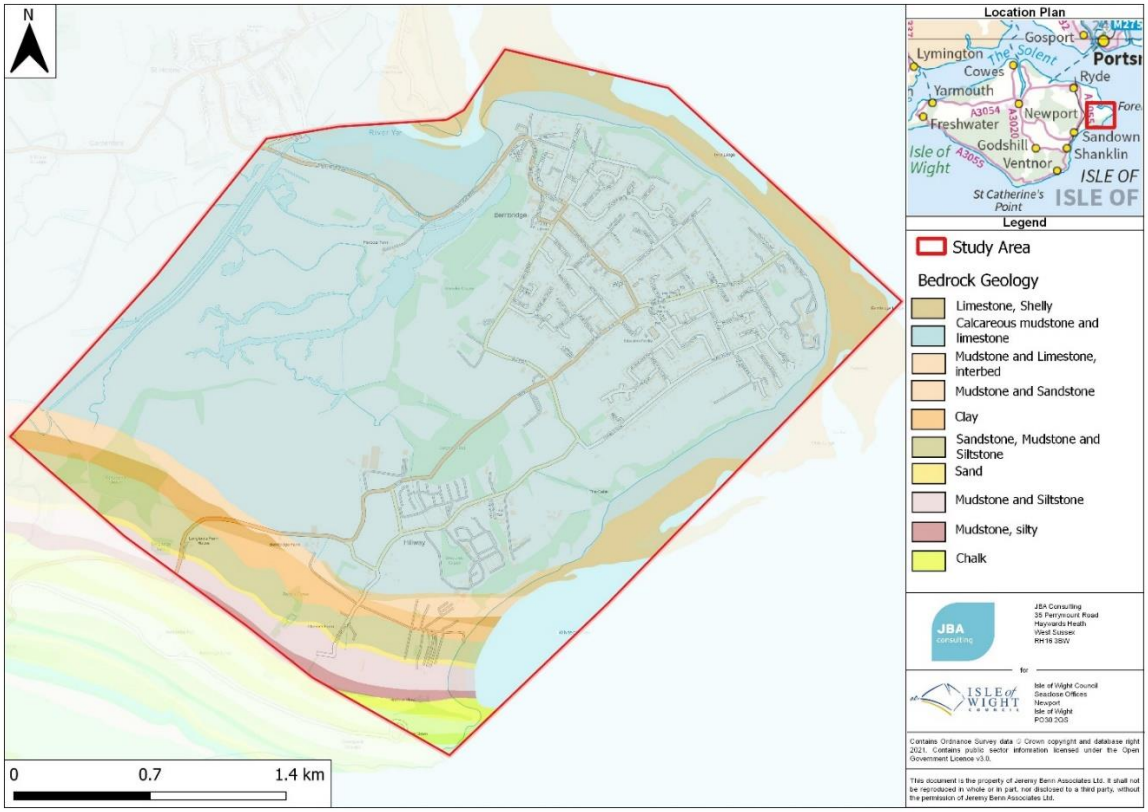

Figure 3-2: Bedrock geology of Bembridge

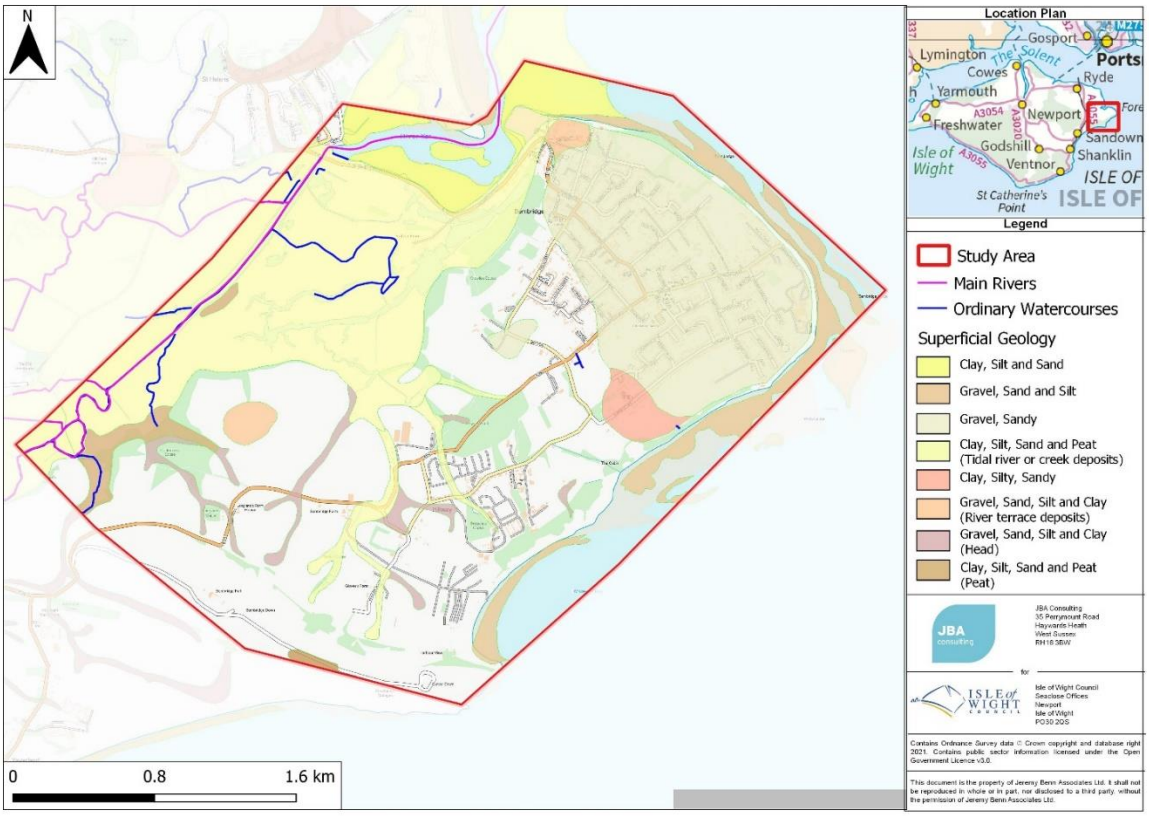

Figure 3-3: The superficial geology of Bembridge

The online Soilscapes map[3] shows four types of soils in the area. From the north to the east of Bembridge there is freely draining loamy soils. However, in the middle and the south east of the area the permeability of the soils is lower, with slowly permeable seasonally wet loamy and clayey soils. Loamy and clayey soils with impeded drainage are found in the south west.

The BGS Aquifer Designation Map[4] shows the majority of the Bembridge area is unproductive, although the chalk to the southwest of Bembridge forms a major aquifer. Ordnance Survey mapping does not show any surface level springs or issues, however it is possible that springs are present at the transition between the chalk and less permeable mudstone when groundwater levels are high. A spring is recorded in Ordnance Survey mapping to the south of Sandown Road at Bembridge airport.

3.3 River network

The Environment Agency has permissive powers to carry out maintenance, improvement and construction work on main rivers in England to manage flood risk. Other rivers are designated as 'ordinary watercourses'. Lead Local Flood Authorities such as the Isle of Wight Council have permissive powers to carry out flood risk management works on ordinary watercourses.

The Environment Agency Main River map and Detailed River Network (DRN) shown in Figure 3-4 provide an indication of where mapped watercourses are located. The Eastern Yar, a main river, flows around the west of Bembridge through the Brading Marshes Nature Reserve and discharges into the Solent at Bembridge harbour.

According to the DRN there are no ordinary watercourses or main rivers passing through Bembridge village, except for a small section of ordinary watercourse to the south west of the village centre, which drains towards Steyne Road. During the site visit in December, the watercourse appeared to be present for surface water drainage of the field.

The Ordnance Survey mapping below also shows watercourses at Hillway and Bembridge Farm. It is believed that the watercourse at Hillway also serves a local drainage function and may not flow permanently, the watercourse at Bembridge Farm is served by a spring in the chalk outcrop, flowing in a northerly direction towards Sandown Road.

[3] Cranfield University http://www.landis.org.uk/soilscapes/

[4] https://magic.defra.gov.uk/MagicMap.aspx

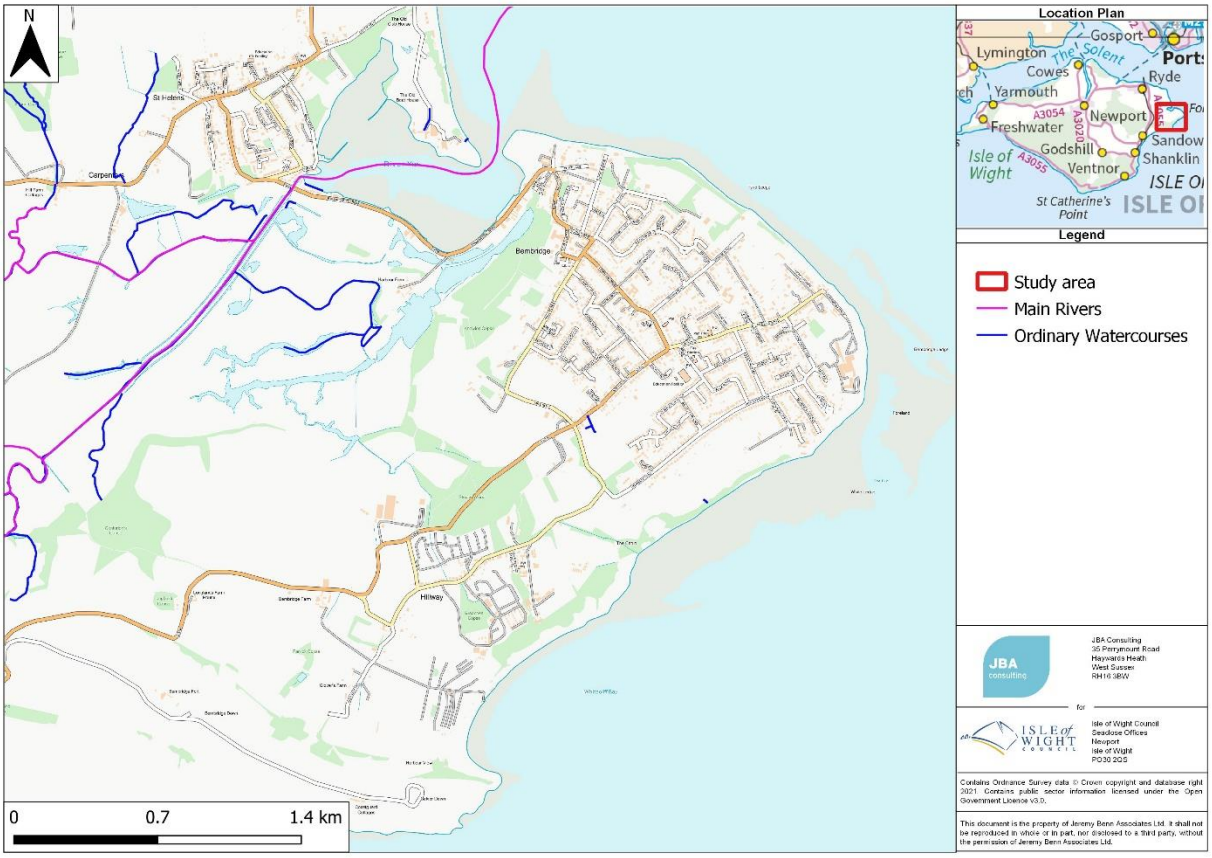

Figure 3-4: The watercourses in Bembridge

3.4 Sewer and drainage network

The wastewater drainage in Bembridge is managed by Southern Water. Bembridge falls within the Sandown New WTW (wastewater treatment works) sewer catchment. The sewage network is made up of gravity sewers and rising mains (pumped systems) with most of the adopted sewers in the centre of Bembridge comprising of a combined system, which receives foul and surface water. When heavy rainfall leads to an increase in flow above the treatment capacity of the WTW, water is stored in storm tanks[5]. If the tanks also reach capacity, they can discharge water through storm overflows into rivers and the sea through Combined Sewer Overflows (CSOs). There are three CSOs in the vicinity of Bembridge.

The highways drainage network across the Isle of Wight is managed by Island Roads, a partnership subject to the terms of the Private Finance Initiative (PFI) agreement with IWC. This includes the maintenance of the network, such as gully and drain cleansing and maintenance of highway ditches as well as the capital expenditure scheme. The agreement has been in place since 2013 and is in place for 25 years.

Correspondence from residents has indicated there are several dry ditches in Steyne Road, which serve a drainage function. An open ditch was located at Station Road during a site walkover which appears to be culverted in the highway. There are also ditches at Sandown Road, Hillway in the vicinity of Bembridge airport which are culverted under the highway. An open ditch also runs in a northerly direction through the Whitecliff Bay Holiday Park, which is visible on OS mapping.

[5] https://www.southernwater.co.uk/media/3904/isle-of-wight-dwmp-strategic-context.pdf

4 Long-term flood risk information

4.1 Risk of flooding from rivers and sea

The Environment Agency's Flood Zone data, shown in Figure 4-1 defines areas at risk of flooding from fluvial and tidal sources. Areas within Flood Zone 2 have a probability of flooding between 0.1% and 1% chance of flooding in any one year from rivers (or between a 0.1% and 0.5% chance of flooding from the sea). Areas within Flood Zone 3 have greater than a 1% chance of flooding from rivers (or greater than a 0.5% chance of flooding from the sea) in any given year.

In the study area, the risk of flooding from rivers and sea is limited to a small area in the west of Bembridge including Solent Landing, Harbour Strand, Station Road and Beach Road. The area surrounding the Eastern Yar, Brading Marsh, Bembridge harbour and the coastline of Bembridge is Flood Zone 2. It should be noted that these Flood Zones represent undefended flood risk and therefore do not consider existing flood defences.

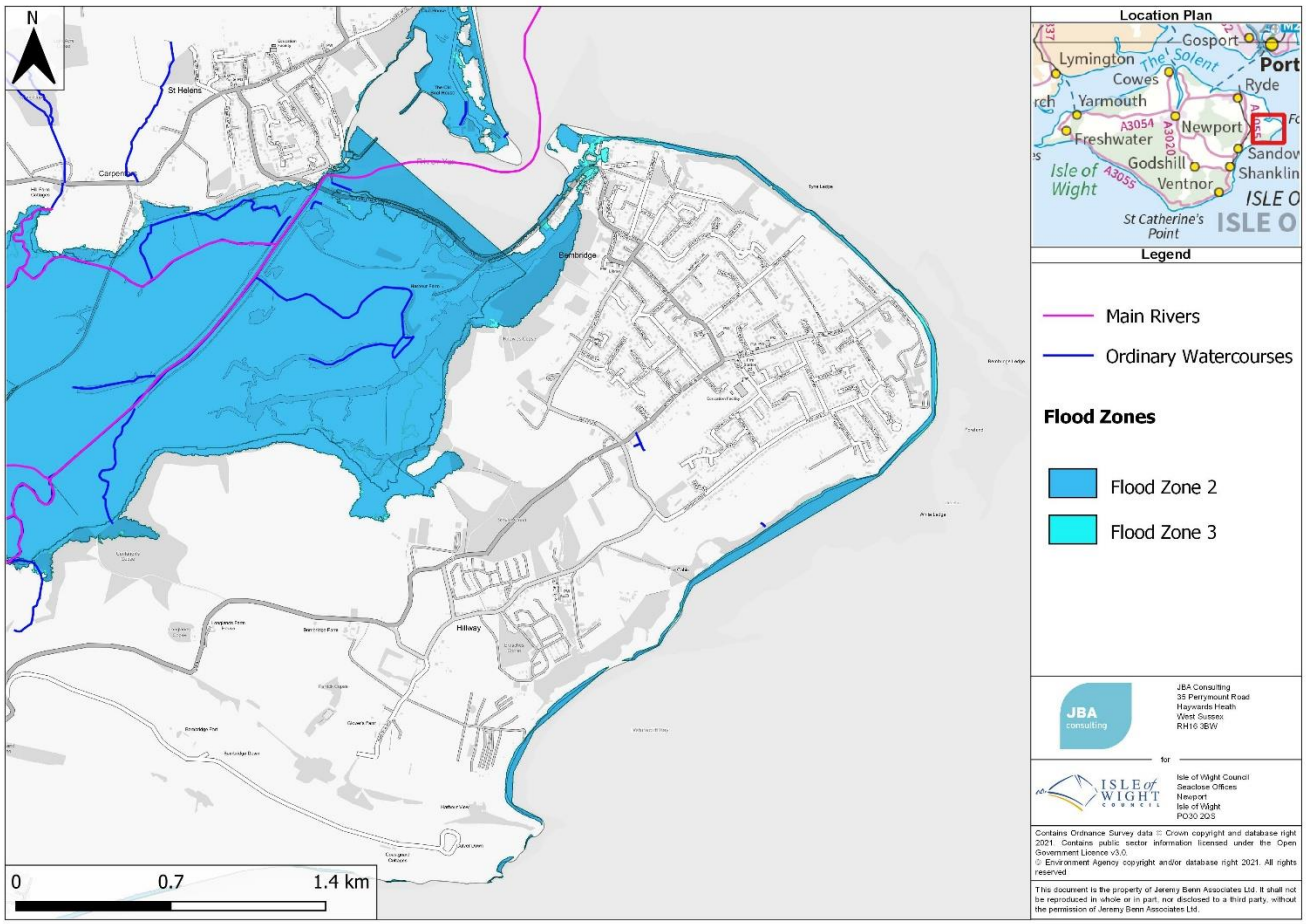

Figure 4-1: Risk of flooding from rivers and sea

It is noted that, whilst low-lying areas of Bembridge are at risk of tidal flooding, the June 2021 flood event was not due to tidal or fluvial flooding.

4.2 Risk of flooding from surface water

Flooding from surface water is caused by intense short periods of rainfall. It often occurs where the natural (or artificial) drainage system is unable to cope with the volume of water. Surface water flooding problems are inextricably linked to issues of poor drainage (or drainage blockage by debris) and sewer flooding.

The Risk of Flooding from Surface Water (RoFSW) is shown in the Environment Agency's RoFSW mapping available online at gov.uk[6]. This national assessment uses a generalised methodology to indicate where water in specific rainfall events might be routed.

The map in Figure 4-2 shows the areas at risk of flooding in response to rainfall events with the following chance of occurring in any given year:

- High risk – greater than a 3.33% chance (1 in 30 years)
- Medium risk – between a 3.33% and 1.0% chance (1 in 100 years)
- Low risk – between a 1.0% and 0.1% chance (1 in 1,000 years)

Surface water flow routes within the Parish predominantly originate from the steep chalk slopes situated to the south. Further mapping showing the study areas in detail is included in Appendix A.

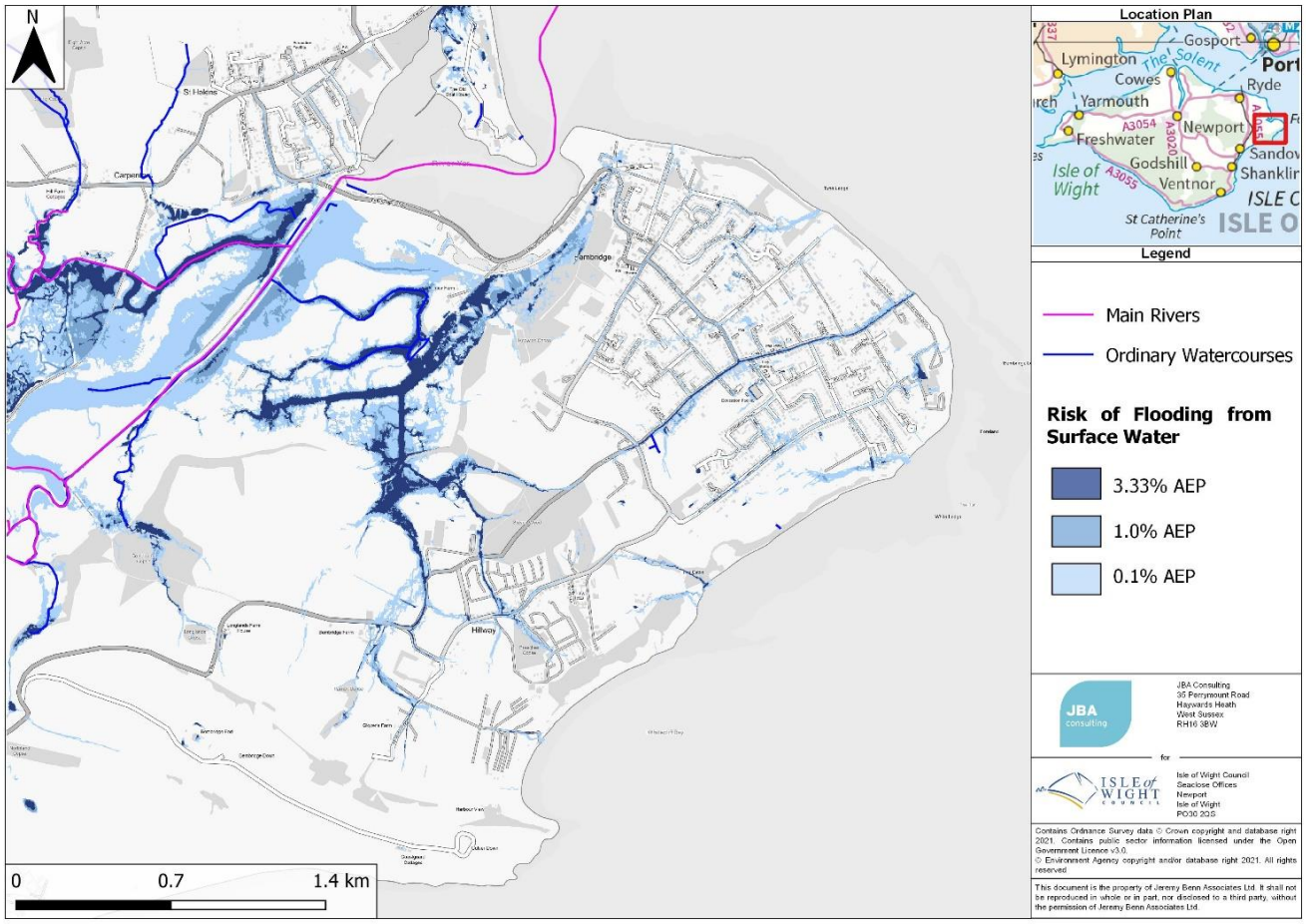

Figure 4-2: Risk of flooding from surface water

6 https://check-long-term-flood-risk.service.gov.uk/map

4.2.1 Hillway/Sandown Road

Distinct flow routes are shown in Figure 4-2 and Appendix A from the northern side of the chalk outcrop at the high-risk event representing the watercourse at Bembridge Farm starting at Glover's Farm and Parrick's Copse, The Glover's Farm and Parrick's Copse pathways flow in a northerly direction before converging at Bembridge Farm.

For the high-risk event, no flow routes are shown at Long Barn on Sandown Road, although a small area of ponding is shown. The exact probability of this is not known as the methodology does not factor in sub-surface drainage networks. The flow route at Long Barn flows through Centurion's Copse towards Brading Marshes

Another flow route is shown in the low-risk event between Longlands and Parrick's Copse, following a similar path to the other flow routes in this area. For all flow routes in all probabilities, surface water flows are generally characterised as shallow and high velocity due to the steep slopes in the area. At Hillway in the high-risk event, surface water is shown generally following the route of the watercourse which flows in a northerly direction. Surface water is shown on Hillway Road where the watercourse is culverted under the road as the culvert is not represented in the modelling. Surface water continues in an open ditch section through the northern part of the holiday park and eventually flows into the Bembridge Lagoons Nature Reserve.

In the medium risk event, surface water is shown flowing from the west and east down Hillway Road before converging at the lowest point with the south-north flows through the holiday park. Flows are again characterised as shallow and fast-moving due to the steep slope at Hillway.

In the low-risk event, the mapping shows significant flooding on Hillway Road and immediately to the north of the road, with flow depths in the region of 300mm-900mm.

4.2.2 Steyne Road

The flow path at Steyne Road is shown in Figure 4-2 above as a largely constrained flow path following the route of Steyne Road to Lane End before flowing out to sea. The upstream convergence of flows from the roundabout at Steyne Road is shown clearly in the photographs in Figure 4-3.

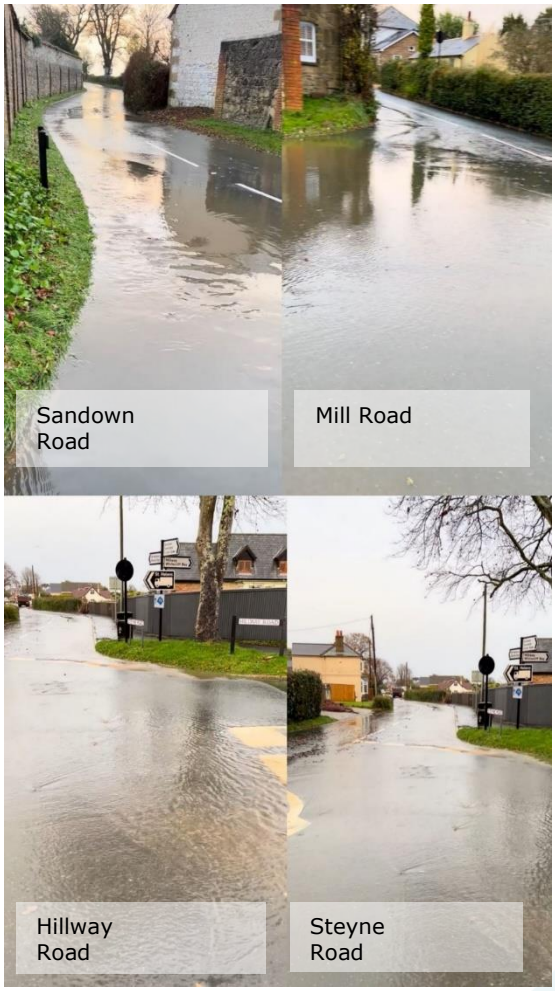

Figure 4-3: Converging flows at Steyne Road (undated)

The surface water continues to flow northeast from Steyne Road to Lane End Road and then to Bembridge Lifeboat Station (Figure 4-4). The locations of these photographs can be seen on Figure 8-2.

Figure 4-4: Lane End Road and Bembridge Lifeboat Station (undated)

4.2.3 High Street/ Station Road/ Solent Landing/ Harbour Strand

In medium risk rainfall events, the RoFSW mapping shows surface water flooding on High Street in the vicinity of Dennett Road, with a flow path from Bembridge High Street in low probability (0.1% annual probability events) predicted to flow down King's Road towards Solent Landing (Figure 11-3).

A flow path is also shown between Dulcie Avenue and Pump Lane in the low-risk scenario, following the route of the bridleway and joining these two roads and the footpaths connecting King's Road and Station Road. A flow route along Harbour Strand is also shown and appears to connect to the Bembridge Lagoons Nature Reserve. Residents reports suggest that flooding occurs from the Station Road junction to the northeast flowing towards the Nature Reserve to the southwest. Surface water accumulations are also shown around Solent Landing and Beach Road. The RoFSW mapping shows no continuity of flow between the Kings Road/Station Road junction and the accumulation at Solent Landing. However, anecdotal information from the June 2021 event suggests that flows from Mill Lane and King's Road entered Solent Landing and Beach Road as well as Station Road and Harbour Strand.

4.3 Groundwater flooding

The mechanisms for groundwater flooding are complex and varied but the 2002 Consultation Report into the Autumn 2000 floods states that in some cases it may not so much be groundwater causing the flooding, as impermeable bedrock restricting the infiltration of rain and thus leading to high rates of surface run-off (Level 1 SFRA 2018).

Chalk and limestone are generally considered to be highly permeable, and no flooding is reported to have occurred in the chalk areas, except along the spring line at the boundary between the chalk base and clay formations. No further detail on the locations of the report floods were included in the SFRA.

Superficial gravel deposits are present above the bedrock within the Village Centre, except for in the south-west. There are no superficial geological deposits at Steyne Road and soil type classifications indicate that drainage in this area is impeded. The area is also situated well above surrounding sea and river levels and, therefore, groundwater is not expected to be a significant flood risk within Bembridge village Nevertheless, geological conditions can vary greatly, and it is noted that there is a transition from superficial gravel deposits to no deposits in this area.

Established springs are recorded on Ordnance Survey mapping at Glovers Farm at the source of one of the surface water flow routes referred to in section 4.2 above. This suggests that there is a groundwater influence on surface flows to the south west of Bembridge Parish.

4.4 Flood history

Table 4-1 below details the known flood history in Bembridge.

Table 4-1: Flood history

Date	Source of flooding	Data Source	Description of impacts
19/10/2019	Unknown	Social Media	Flooding of Bembridge High Street. Video taken from the door of The Old Village Inn pub.
18/11/2019	Adopted sewer network	Southern Water	Two cases of flooding in Bembridge
05/09/2019	Adopted sewer network	Southern Water	Flooding in Bembridge
08/01/2015	Adopted sewer network	Southern Water	Flooding in Bembridge
24/12/2013	Surface water flooding	Unknown	Internal flooding to one property on Steyne Road, Bembridge, PO35 5SL.
Autumn 2000	Surface water flooding	The Isle of Wight Autumn 2000 Flood Investigation Study (Bembridge Parish Council Report)	High Street - Flooding of shop, reportedly due to poor maintenance of the private yard drainage. Steyne Road – internal flooding to property built in a dip and below the road level. Surface water flows off the recreation ground and playing fields into the property. Water accumulates in the road at this point, reportedly due to under capacity of the road drains. Steyne Road – internal flooding to property during the heavy rains, when the capacity of the ditch behind the house was exceeded.

5 Flood risk management

Responsibility for flood risk can be divided into "flood risk management" and "emergency response". The following section describes the roles of the various bodies involved in flood management, with roles and responsibilities for emergency response described in Section 5.2.

It should be noted that the responsibility for reducing the impacts of flooding to any property remain with the owner of that property, not with any risk management authority. Isle of Wight Council, the Environment Agency and other risk management authorities have the statutory powers to carry out works for flood risk management purposes or other works to reduce flooding but are under no statutory duty to do so.

5.1 Flood risk management roles and responsibilities

Flood risk in England is managed by a range of different Risk Management Authorities (RMAs)[7]. The Flood and Water Management Act places a duty on all flood risk management authorities to co-operate with each other. The act also provides Lead Local Flood Authorities and the Environment Agency with a power to request information required in connection with their flood risk management functions.

5.1.1 Lead Local Flood Authority (LLFA)

LLFAs are responsible for managing the risk of flooding from surface water, groundwater (water which is below the water table under the ground) and ordinary watercourses (non-main rivers) and lead on community recovery. The LLFA is also responsible for developing, maintaining and applying a strategy for local flood risk management in their area and for maintaining a register of flood risk assets. Isle of Wight Council is the LLFA for Bembridge.

5.1.2 Environment Agency

The Environment Agency is a non-departmental public body sponsored by the Government's Department for Environment, Food & Rural Affairs (Defra), and is tasked with the protection and conservation of the water environment in England, the natural beauty of rivers and wetlands and the wildlife that lives there.

The Environment Agency's responsibilities include water quality and resources; fisheries; conservation and ecology; and operational responsibility for managing the risk of flooding from main rivers (usually large streams and rivers), reservoirs, estuaries and the sea.

Flood risk management work can include constructing and maintaining 'assets' (such as flood banks or pumping stations) and works to main rivers to manage water levels and make sure flood water can flow freely; operating flood risk management assets during a flood; channel maintenance on the river; issuing flood warnings; and responding to incidents.

The Environment Agency can also do work to prevent environmental damage to watercourses, or to restore conditions where damage has already been done.

The strategies for flood and coastal erosion risk management show how communities, the public sector and other organisations can work together to manage this risk.

5.1.3 Water and Sewerage Company

Water and sewerage companies are responsible for managing the risks of flooding from surface water and foul or combined public sewer systems providing drainage from buildings and yards. Southern Water is the water and sewerage company for Bembridge.

7 https://www.gov.uk/guidance/flood-risk-management-information-for-flood-risk-management-authorities-asset-owners-and-local-authorities

5.1.4 Highway Authority

The Highway Authority for Bembridge is the Isle of Wight Council, and the highways' function is managed by Island Roads. It is responsible for maintaining the highway drainage system to an acceptable standard and ensuring that road projects do not increase flood risk'

5.1.5 Riparian landowners

Riparian landowners who own land or property next to a river, stream or ditch, (including where this runs through a pipe or culvert), have rights and responsibilities over the management of the land including: a responsibility to let water flow through the land without any obstruction, pollution or diversion which affects the rights of others; keeping banks clear of anything that could cause an obstruction and increase flood risk; maintaining the bed and banks of the watercourse; and keeping structures clear of debris. There is more information on these rights and responsibilities in the Environment Agency's online guidance 'Owning a watercourse'[8].

5.1.6 Local residents

Local residents should find out about any flood risk in the area, sign up for the Environment Agency's free flood warnings and make a written plan of how they will respond to a flood situation. Business owners should also make a flood plan for their business. There are measures that can be taken to reduce the amount of damage caused by flooding and properties at risk should be insured. Local residents can find out if their property is at risk, prepare for flooding, get help during a flood and get help after a flood.

5.2 Emergency responsibilities

The responsibilities of different organisations in an emergency, during and after a flood event are outlined in

8 Environment Agency (2018) Owning a watercourse. Available at: https://www.gov.uk/guidance/owning-a-watercourse

Table 5-1**Error! Reference source not found.** below. Parish and Town Councils do not have a legal obligation to respond to emergencies. Any service they provide is voluntary and unique to each Parish or Town Council.

Table 5-1: Roles and responsibilities in an emergency

Local (County and District) Authorities
Coordinate emergency support within their own functions Deal with emergencies on 'non main rivers' Coordinate emergency support from the voluntary sector Liaise with central and regional government departments Liaise with essential service providers Open rest centres Manage the local transport and traffic networks Mobilise trained emergency social workers Provide emergency assistance Deal with environmental health issues, such as contamination and pollution Coordinate the recovery process Manage public health issues Provide advice and management of public health Provide support and advice to individuals Assist with business continuity

Police Force	Utility Providers
Save life Coordination and communication between emergency services and organisations providing support Coordinate the preparation and dissemination	Attend emergencies relating to their services putting life at risk Assess and manage risk of service failure Assist with recovery process, that is, water utilities manage public health considerations

Fire and Rescue Service	Ambulance Service
Save life rescuing people and animals Carry out other specialist work, including flood rescue services Where appropriate, assist people where the use of fire service personnel and equipment is relevant	Save life Provide treatment, stabilisation and care at the scene

Town and Parish Councils	Voluntary Services
Support emergency responders Increase community resilience through support of community emergency plan development	Support rest centres Provide practical and emotional support to those affected Support transport and communication Provide administration Provide telephone helpline support

Environment Agency
Issue Flood Warnings and ensure systems display current flooding information
Provide information to the public on what they can do before, during and after a flood event
Monitor river levels and flows
Work with professional partners and stakeholders and respond to requests for flooding information and updates
Receive and record details of flooding and related information
Operate water level control structures within its jurisdiction and in line with permissive powers
Flood event data collection
Arrange and take part in flood event exercises
Respond to flooding incidents
Respond to pollution incidents and advise on disposal
Assist with the recovery process, for example attending flood surgeries
Advise upon and regulate flood risk activities on, and within the flood plains of main rivers

5.2.1 Local Resilience Forum (LRF)

Local resilience forums (LRFs) are multi-agency partnerships made up of representatives from local public services, including the emergency services, local authorities, the NHS, the Environment Agency and others. These agencies are known as Category 1 Responders, as defined by the Civil Contingencies Act.

LRFs are supported by organisations, known as Category 2 responders, such as the Highways Agency and public utility companies. They have a responsibility to co-operate with Category 1 organisations and to share relevant information with the LRF. The geographical area the forums cover is based on police areas.

The Local Resilience Forum is not a legal entity, nor does a Forum have powers to direct its members. Nevertheless, the Civil Contingencies and the Regulations provide that emergency responders, through the Forum, have a collective responsibility to plan, prepare and communicate for emergencies in a multi-agency environment.

The Local Resilience Forum for Bembridge is the Hampshire and Isle of Wight Local Resilience Forum (HIWLRF). The HIWLRF has identified coastal flooding, fluvial flooding and surface water flooding as very high risk. Therefore, the HIWLRF has a Multi-Agency Flood Response Plan that provides the framework for the multi-agency response to a flooding incident and details the roles and responsibilities of each agency, as well as the estimated time of onset for flooding, the number of properties at risk, vulnerable receptors and safe evacuation points. THE HIWLRF also work with communities at risk to create Community Emergency Action Plans.

The Island Resilience Forum (IRF) was formed as a sub-group of the HIWLRF to provide an Isle of Wight dimension to planning, concentrating on the risks and challenges faced by island communities. The IRF consists of a tactical level coordinating group of emergency planners to facilitate joint working between island partners.

5.3 Existing flood risk management activities

The IWC Local Flood Risk Management Strategy[9] (2016) details the various responsibilities of key stakeholders and organisations, and the existing flood risk management activities at the time.

In relation to tidal flooding, the Environment Agency is planning to sustain the Embankment Road flood defence to ensure that it continues to provide the same standard of protection for

[9] https://www.iow.gov.uk/azservices/documents/2821-IW-Local-Flood-Risk-Management-Strategy-2016.pdf

the next 100 years. This will maintain protection to around 450 properties that would be at risk of tidal flooding if the embankment was not there.

There are currently no known flood risk management activities relating to other sources of flooding in Bembridge.

5.3.1 Flood warning service

A flood warning service exists for coastal areas at Bembridge around Bembridge Harbour and includes Harbour Strand, Station Road, Beach Road and Solent Landing. This service provides communication of flood alerts and warnings by phone, text or email once registered through the government website[10].

There is no flood warning service for ordinary watercourses or surface water flooding.

Figure 5-1 maps the location of the two flood warning areas that cover the Bembridge study area. These areas are as follows:

- Bembridge (Coastal areas at Bembridge)
- Sandown, Brading and Bembridge on the Eastern Yar (Sandown, Yaverland, Yarbridge, Brading and Bembridge on the Eastern Yar).

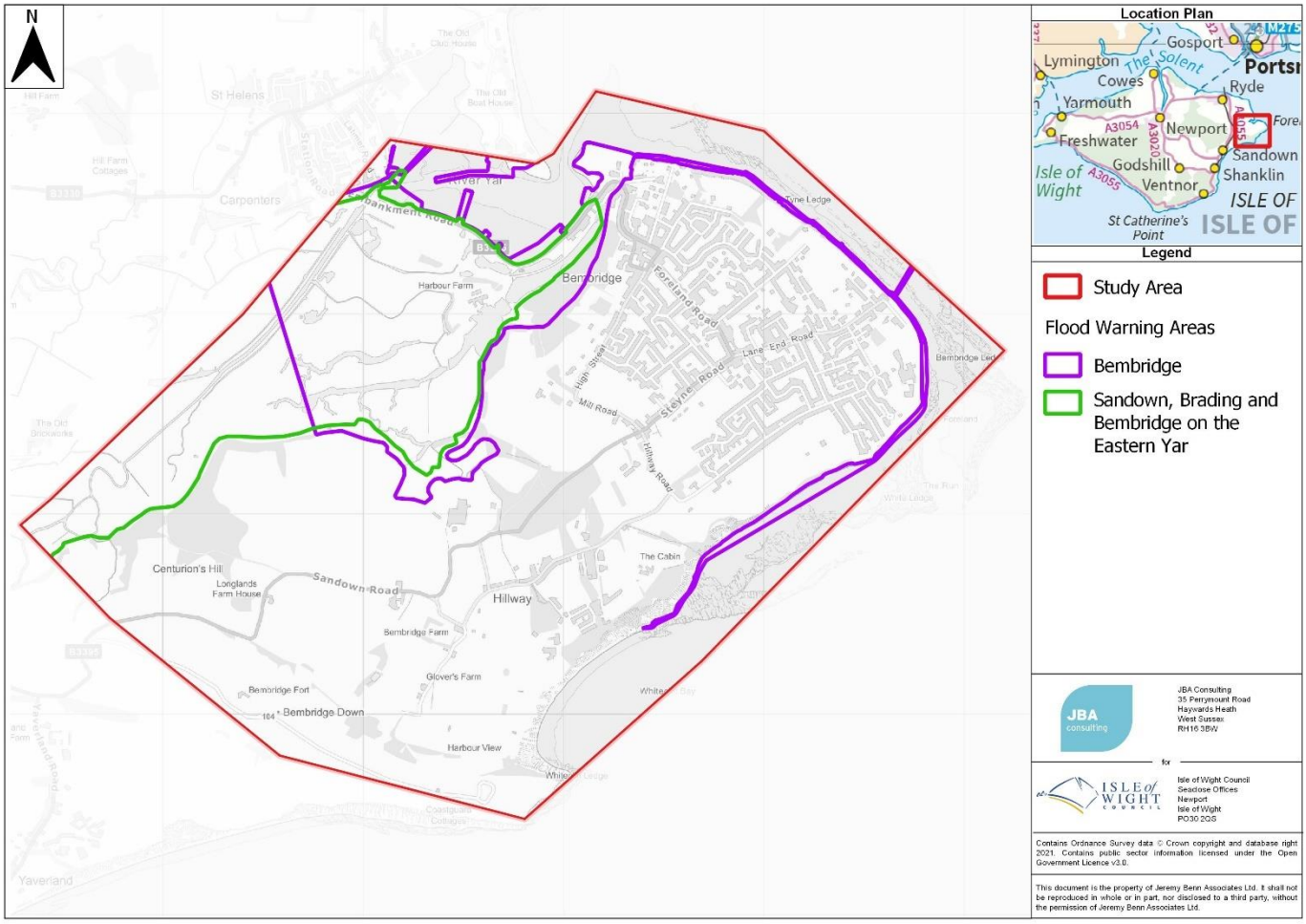

Figure 5-1: The Environment Agency Flood Warning Areas

[10] https://www.gov.uk/sign-up-for-flood-warnings

5.3.2 Community flood plans

There is no local Flood Action Group for Bembridge, however, Bembridge Parish Council has a Community Emergency Plan[11], last updated in July 2017. This plan was not used during the flood event in June 2021 and is currently being updated.

5.3.3 Maintenance

- Maintenance is an essential part of managing flood risk, with landowners, the IWC and EA involved in the maintenance of watercourses, drains and similar infrastructure, as shown in

Table 2-1.

The legal responsibility for maintenance of watercourses and ditches (as defined by the Land Drainage Act 1991 and set out in Section 0) lies with the riparian landowners rather than Risk Management Authorities. The Environment Agency and Lead Local Flood Authority have powers to work on main rivers and ordinary watercourses respectively to manage flood risk. However, these powers are permissive, which means they are not a duty.

Island Roads has an annual programme of drain and gully cleansing for roads and are responsible for managing sandbag stock at strategic locations. It is noted that the road cleansing and subsurface cleansing are managed under separate contracts by Island Roads.

Southern Water are responsible for maintenance of the adopted water supply and wastewater systems.

[11] https://www.bembridgepc.org.uk/wp-content/uploads/2017/09/Bembridge-Emergency-Plan-18-July-2017.pdf

6 Hydrological analysis

6.1 Methodology

Rainfall radar data (HYRAD) from the Met Office has been obtained and analysed as no rain gauges are situated near the Bembridge study area. Each pixel represents real-time radar rainfall data for an area of 1 km^2. Point descriptors from the Flood Estimation Handbook (FEH) web service were used to calculate the probability of the storm occurring for different storm durations.

There were many reports of flooding from June and July 2021 which were undated, or which had conflicting dates. This has caused uncertainty in whether flooding occurred on one or multiple dates throughout June and July 2021 with reports of flooding on June 27, 28 and 29 June 2021. Analysis of rainfall records on those dates identified the overnight rainfall of 28 – 29 June as the most likely date for flooding to have occurred.

The dates provided for flooding in July were 1, 7, 25, 27 and 28 July 2021. Hydrological analysis revealed no rainfall on 1, 7 or 28 July and no tidal/fluvial flood risk to the Bembridge area. Although there was some rainfall recorded on 25 July, it was not of a significant intensity to be classified as a major storm event. In addition, there was a burst water main reported on Mill Lane in Bembridge which corresponds to the records of flooding on this date. A storm event was recorded on 27 July and matched the 5-hour time frame provided by respondents to the survey from this S19 investigation. However, the storm event that affected Bembridge at night on 27 July was likely to have had between a 20% to a 50% probability of chance of occurring in any given year, which can be expressed as between a 1 in 5-year and a 1 in 2-year rainfall event. This is not considered to be an extreme rainfall event

Following this assessment, it was established the most likely date for flooding in Bembridge was 28 - 29 June 2021, with repeat flooding to at least property outside of the village centre on 27 July 2021. The hydrological analysis in this section of the report will focus on the 28 – 29 June 2021 storm event.

6.2 28 to 29 June 2021 storm event

Rainfall data from 28 June 2021 shows that the weather was relatively dry until approximately 19:00, when rainfall began. The storm event continued until 02:00 on 29 June 2021, lasting 7.5 hours in total.

The HYRAD records show that two distinct peaks in rainfall intensity at 21:15 on 28 June and between 00:00 and 00:30 on 29 June, with averaged hourly rainfall between the peaks ranging between 5mm and 6mm per hour. The latter peak was the most intense shower, lasting around two hours in the early hours of 29 June. Figure 6-1 presents the peak rainfall recorded at each pixel on 29 June 2021 from 00:00 to 00:30. The rainfall continued until approximately 02:30 on 29 June.

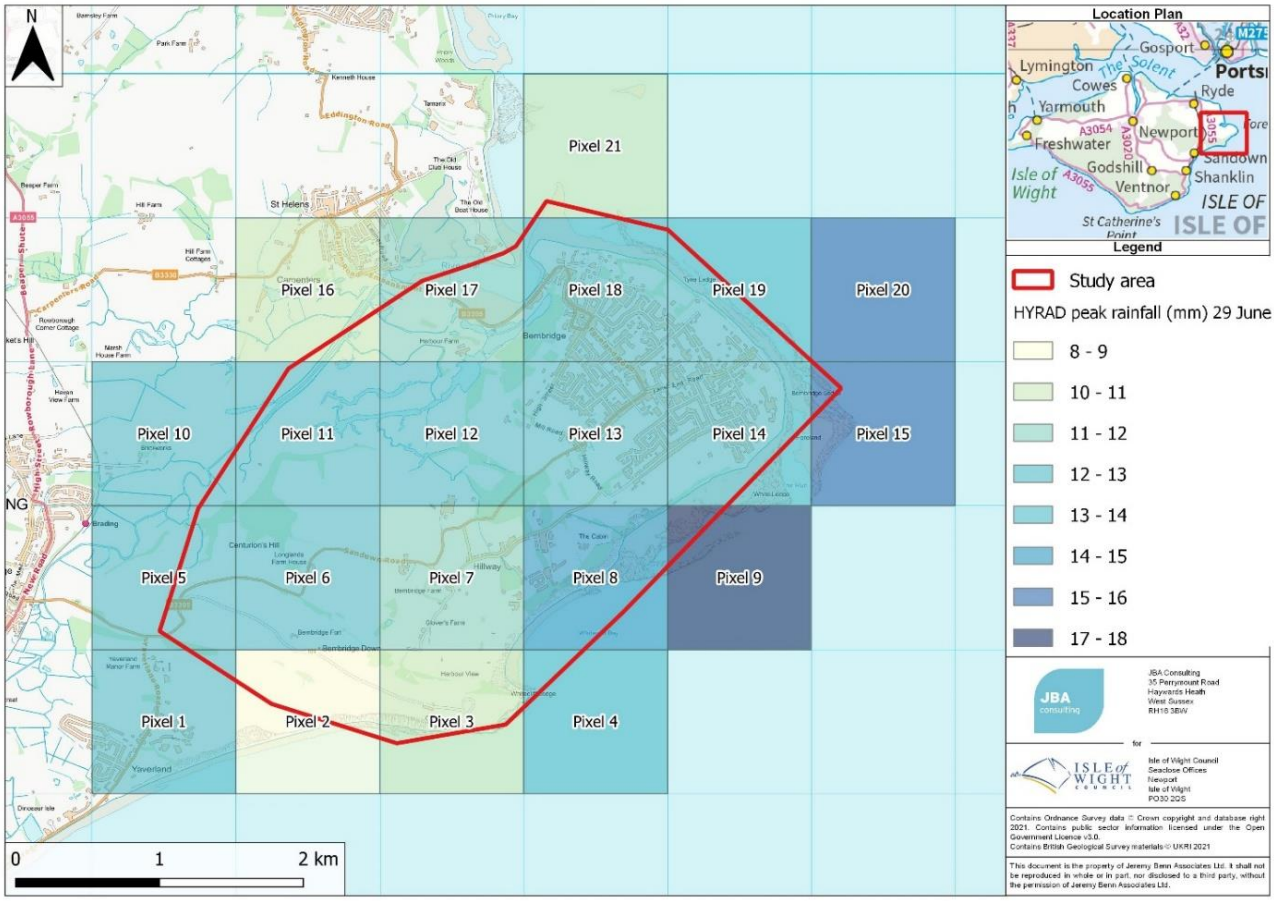

Figure 6-1: HYRAD peak rainfall on 29 June 2021

Compared to the first peak, the peak rainfall intensities in the second peak were higher for a longer duration, as shown in Table 6-1 below. The table also shows the peak storm intensities were extremely localised, with a difference of 4.5mm within a 15-minute interval between rainfall at Hillway (pixel 7) and the Village Centre (pixel 13).

Table 6-1: Rainfall peak comparison

HYRAD Pixel	Peak rainfall at 21:15 (mm)	Peak rainfall at 00:30 (mm)
Pixel 7	6.44	11.31
Pixel 13	10.97	14.00
Pixel 18	7.41	12.16

6.2.1 Rainfall return period estimation

The probability of the rainfall occurring was calculated for a 1-hour period, and a 4-hour period (storm duration). This allowed for assessment of both of the storm peaks individually, as well as considering a storm duration which would include both peaks.

Table 6-2 shows the calculated storm probabilities (return periods) for a 1-hour storm duration and Table 6-3 the probability of the storm over a 4-hour storm duration. The storm event that affected Bembridge over night from the 28 – 29 June 2021 was likely to have had approximately a 2% to 5% probability of occurring per year, which can be expressed as a between a 1 in 50 and a 1 in 20 year storm event. Therefore, the storm event was an extreme rainfall event, with a large volume of rainfall occurring in a relatively short amount of time.

Table 6-2: Probability of the rainfall event on 28 – 29 June 2021 (1 hour storm duration)

HYRAD Pixel	Rainfall total (mm)	Return Period (years)	Approximate annual probability
Pixel 6	37.79	50.5	2%
Pixel 7 (Hillway)	33.69	29.8	3.3%
Pixel 8	38.84	57.8	2%
Pixel 12	37.19	46.8	2%
Pixel 13 (Village centre)	37.47	48.5	2%
Pixel 14	38.18	53.1	2%
Pixel 17	29.15	16.62	5%
Pixel 18 (High Street to Solent Landing)	37.66	49.7	2%
Pixel 19	36.84	44.7	2%

Table 6-3: Probability of the rainfall event on 28 – 29 June 2021 (4 hour storm duration)

HYRAD Pixel	Rainfall total (mm)	Return Period (years)	Approximate annual probability
Pixel 6	45.77	20.21	5%
Pixel 7 (Hillway)	39.74	10.46	10%
Pixel 8	43.62	15.95	5%
Pixel 12	44.03	16.68	5%
Pixel 13 (Village centre)	44.55	17.66	5%
Pixel 14	45.31	19.21	5%
Pixel 17	38.9	9.55	10%
Pixel 18 (High Street to Solent Landing)	44.13	16.86	5%
Pixel 19	44.43	17.43	5%

6.2.2 Summary

The analysis shows that the peak rainfall intensity had between a 5% and 2% chance of occurring in any given year (a 1 in 20 to 1 in 50 year storm event). The storm events were also short-lasting, as shown by comparing the probability of the 1 hour storm (2-5%) to the 4 hour storm (5-10%).

This indicates a relatively rapid response of the catchment to rainfall, which can be explained by the steep, urbanised characteristics of the catchment and impeded drainage of the soils and underlying geology.

It is therefore possible to conclude that the flooding was driven by the intensity of the rainfall that occurred during the 1 hour period rather than antecedent (previous) conditions.

7 Incident response

During the flood event on 28 - 29 June 2021 Island Roads were called out to The Old Village Inn pub to pump out flood water and road grit. A drain was also unblocked in the process. Isle of Wight Fire and Rescue was called six times on 29 July between around 01:30 and 05:00. The calls were from High Street, Hillway Road, Beach Road and Harbour Strand. Advice was given but Fire and Rescue did not attend during the event. No other responses were recorded, and it is understood that no Met Office weather warnings were issued for the Isle of Wight for this rainfall event.

On 25 July the emergency services received three calls about flooding from around 20:30 to 20:45. Residents of the Mill Road/ Steyne Road area were given advise by Isle of Wight Fire and Rescue, but no other response was recorded. Upon inspection of the rainfall data for this date, it was noted that there was no rainfall, and it is understood that the reported flooding relates to a burst water main on Mill Lane.

There are no recorded responses for 27 July.

A timeline of the incident response for the 28 - 29 June 2021 event is provided in Table 7-1.

Table 7-1: Timeline of incident response

Date	Time	Activity/event	Agency
28/06/2021 – 29/06/2021	Night	24,000 litres of water and road grit pumped out of The Old Village Inn pub. A drain was also unblocked in the process. Prior to this residents and staff helped to clear water.	Island Roads
29/06/2021	01:29:11	High Street, Bembridge: Call about property flooding Advice given	Isle of Wight Fire and Rescue.
29/06/2021	02:04:40	High Street, Bembridge: Call about flooding Advice given	Isle of Wight Fire and Rescue.
29/06/2021	02:19:24	Hillway Road, Bembridge: Call about flooding Advice given	Isle of Wight Fire and Rescue.
29/06/2021	02:20:24	High Street, Bembridge: Call about flooding Advice given	Isle of Wight Fire and Rescue.
29/06/2021	03:17:12	Harbour Strand, Bembridge: Call about flooding Advice given	Isle of Wight Fire and Rescue.
29/06/2021	04:53:12	Beach Road, Bembridge: Call about flooding Advice given	Isle of Wight Fire and Rescue.

8 Source-pathway-receptor analysis

The Source-Pathway-Receptor model is a concept that can provide an understanding of all aspects of flood hazard. It breaks a flood incident down into three elements:

- Source - the origin of flood water
- Pathway - a route or means by which a receptor can be affected by flooding
- Receptor - something that can be adversely affected by flooding (e.g., people, property, infrastructure)

We analysed all available information to determine the main sources of the flood water, the pathways it took and the main receptors. These are summarised and described in the following sections Figures 8-1 and 8-2 provide an overview of the flow paths during the flood event on 28 – 29 June 2021.

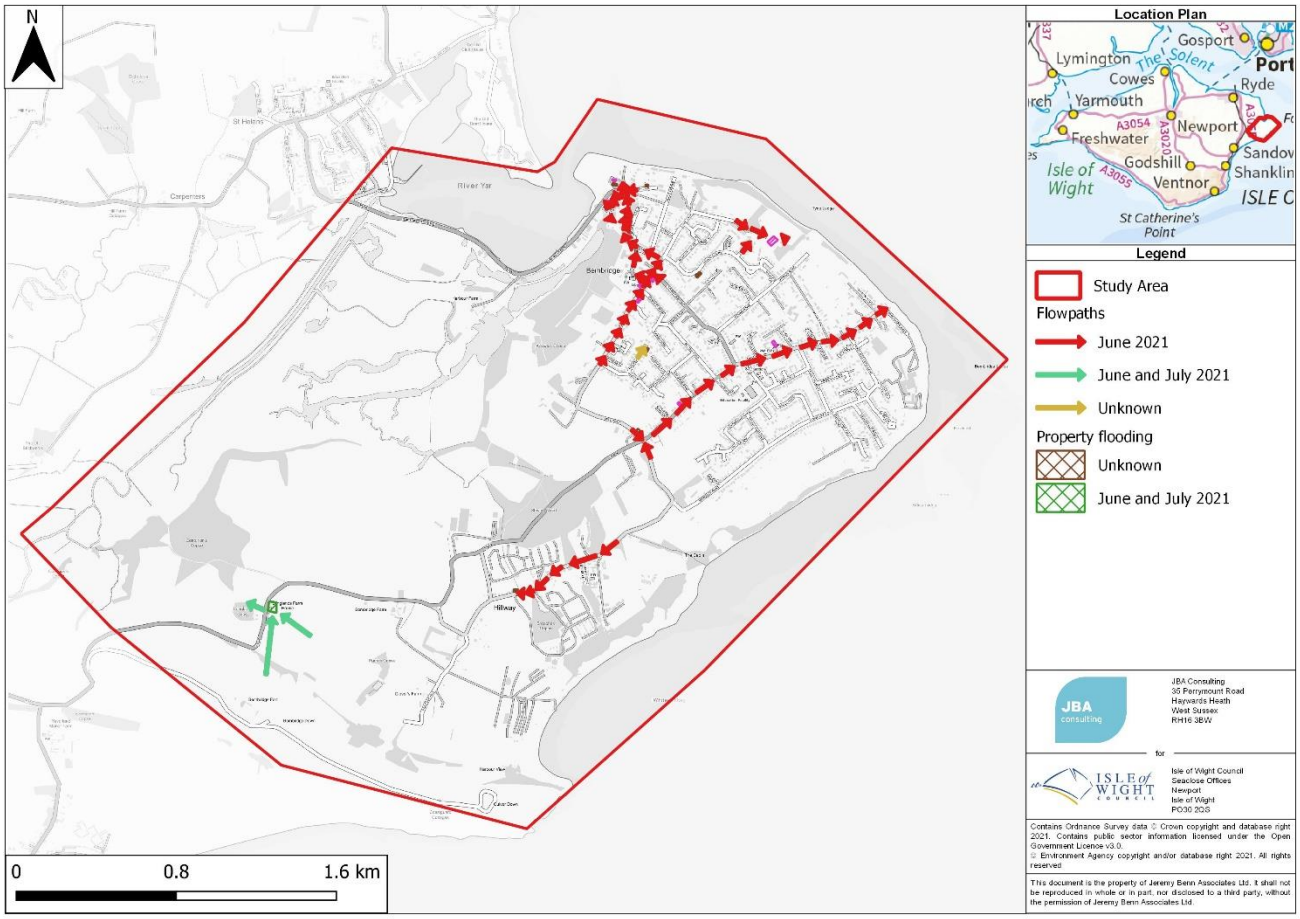

Figure 8-1: Overview of sources, pathways and receptors

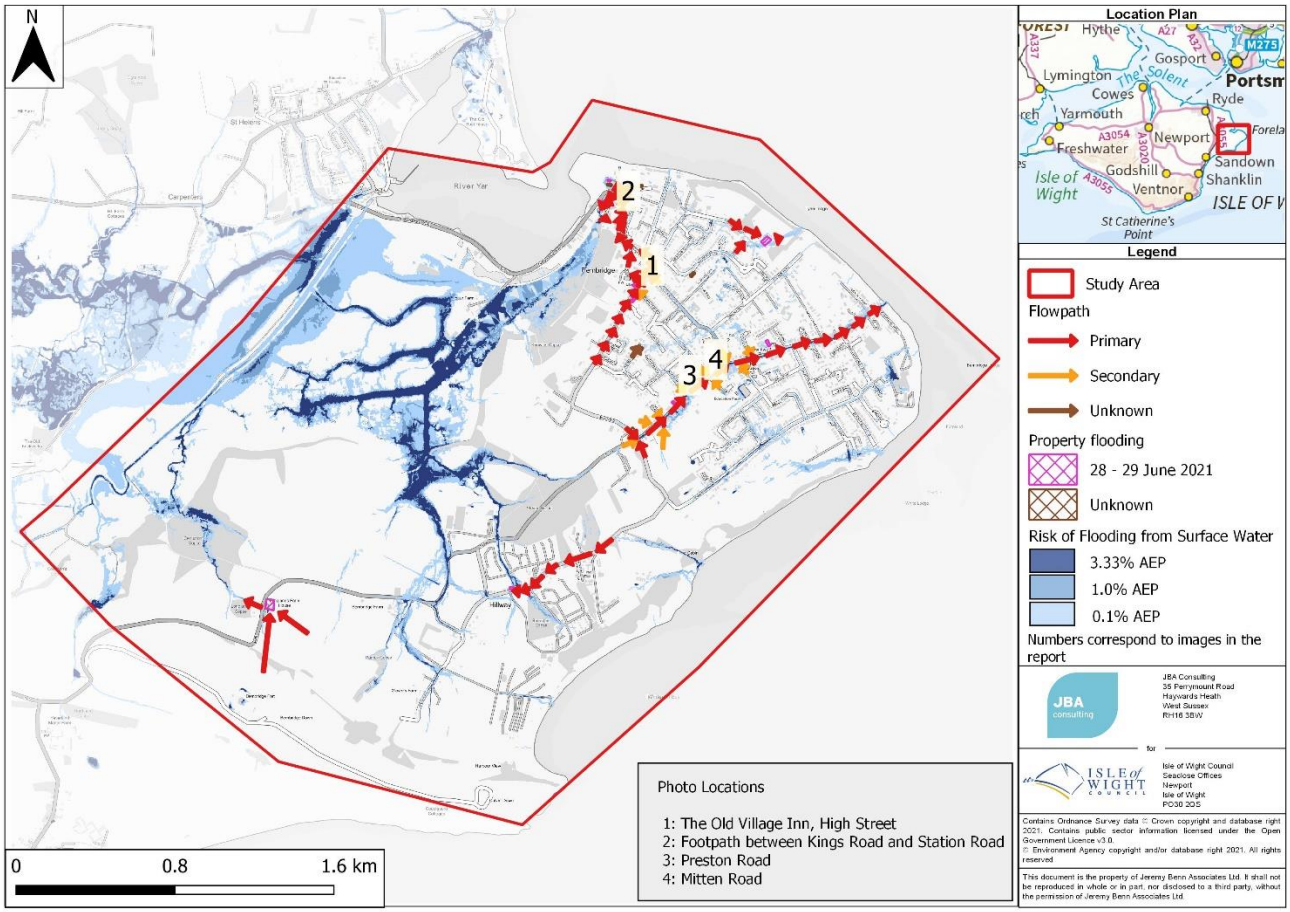

Figure 8-2: Sources, pathways and receptors for June 2021 event

8.1 Source

8.1.1 Extreme rainfall

The rainfall event on 28 to 29 June 2021 was a significant rainfall event, with a 2% - 5% probability of occurrence in any given year (1 in 50 to 1 in 20 year event). The intense rainfall experienced in Bembridge caused a large volume of water to fall directly onto the ground surface in the village, leading to diffuse sources of flooding. Responses from residents and the hydrological analysis indicated that the period of intense rainfall started at approximately 11:00 and continued until 01:00. The rainfall event had several peaks of rainfall intensity across the event from around 19:00 on 28 June until 02:00 on 29 June.

The respondents to the survey have identified surface water runoff from surrounding fields as a source of flooding. This includes the field to the south of Steyne Road (Figure 8-3).

Figure 8-3: Field to the south of Steyne Road

The Environment Agency's monthly water situation report for June 2021 states that the Solent and South Downs (SSD) Area "had well above average rainfall in June receiving 186% (103mm) of the long-term average (LTA) (55mm)". The rainfall in June was the third highest on record. The Isle of Wight had exceptionally high rainfall in June receiving 231% (116mm) of the long-term average (LTA) (50mm). Most of the rainfall fell at the end half of the month.

The highest daily rainfall value for the period was recorded on 28 June, with 51.3mm of rain recorded at Ryde Vineyard, 5.5 km away from Bembridge. The soil moisture in June was higher than average for the time of year and groundwater levels were normal to above normal.

Where Bembridge is underlain by Bembridge Marls, Standard Percentage Runoff (SPR) in the region of 50%. Given the underlying geology and soil conditions prior to the rainfall on 28 - 29 June, it is expected that the high rainfall intensity would have been far greater than the infiltration capacity of the saturated soils at this location, causing surface water ponding and the formation of overland flow paths and shallow flow paths through the surface soils. It is therefore likely that soils at the lowest elevations will remain saturated for longer as water continues to drain down the slope after an event, leading to longer-duration surface water flooding at the bottom of the slope.

8.1.2 Groundwater

At Longlands Farm, the possibility of flooding due to groundwater was investigated due to its position at the base of the chalk outcrop where the geology transitions from chalk to clay. Reports from property owners indicated seeing the emergence of springs and a recorded spring close to Bembridge Farm is at a similar elevation to flooding above Long Barn.

Groundwater records of the area were requested from the Environment Agency, with the nearest monitoring station at Bembridge Fort located approximately 500m to the south west. Groundwater monitoring from the 28 – 29 June 2021 showed that the groundwater level on the 28 - 29 June was higher than average. However, despite the proximity of the groundwater monitoring station to the site, the Chalk is very steeply dipped in that area to an almost vertical level meaning groundwater levels in other nearby Chalk areas may not be comparable given due to relative difference in porosity between layers. Given that a spring is recorded at a similar elevation at Glovers Farm, the possibility of groundwater flooding cannot be discounted. This is the only location where flooding is known to have occurred in June and July 2021, indicating a mechanism which was very sensitive to rainfall events over the space of the month between the two events.

8.1.3 Combined sewer

Southern Water advised the authors of the 2010 SFRA (Appendix L of the SFRA) that surface water modelling carried out as part of the assessment should assume a 1 in 20 year storm event capacity for the surface water sewer network. Southern Water has also stated that many of the sewers listed as foul in the asset mapping may be combined systems which receive foul and surface water. However, there is currently no data available to support or change the current assumptions.

Due to the presence of foul sewage identified in the flood water, the sewer system is considered to have been an additional source of flooding. Based on the hydrological analysis from the 28 to 29 June event, the recorded rainfall is estimated to have been between a 1 in 20-year and 1 in 50-year rainfall event, which is expected to have exceeded the capacity of this sewer system. This would have resulted in foul sewage emerging from the sewer manholes and mixing with flood water. The assertion that the sewer network was exceeded during the event is supported by the release history for the Hillway Bembridge CSO discharge point, which shows that the CSO was activated on the 28 June 2021 (16.20 hours duration). Similarly for Lane End Road Bembridge, the CSO was activated for 42.48 hours on 28 June 2021.

8.1.4 Highway drainage

High Street/Station Road/Solent Landing/Harbour Strand

Responses collected as part of this S19 investigation reported blockage and exceedance of the highway drainage network as a contributing source of flooding during the 28 – 29 June 2021 event.

Whilst details of the highway network such as gully locations have been provided by Island Roads, the drainage capacity of the highway drainage network is unknown and therefore it has not been possible to verify resident's reports of highways drainage capacity issues for High Street on 28 - 29 June 2021. There is a correlation between reports of restricted highways drainage capacity and the locations of surface water flow paths along Kings Road connecting the High Street to lower-lying areas such as Station Road, Solent Landing and Harbour Strand, joining another flow path from Pump Lane. It is noted that Island Roads are highly unlikely to have any information regarding highways drainage for unadopted roads such as Pump Lane as they have no maintenance responsibilities for these areas.

An Island Roads operative who attended the site reported that a large blockage of fat had been lodged in the pipe that run from 63 High Street to the gully outside the Olde Village Inn and there was gravel encountered in the pipe when clearing. The operative stated that this was confirmed by the CCTV survey data of the drainage (not received for this report). It is also unconfirmed whether the blockage was encountered in the adopted

sewer network or in the highway drainage network, however the highway maintenance schedule received from Island Roads also indicates that scheduled maintenance of the drainage systems had taken place ahead of the event.

Gravel washed into the highway drainage system was raised as a concern by local residents. Reports also mentioned that the openings to in-kerb slot drains (locally referred to as letterboxes) were too narrow for the volume of surface water to enter the highway drainage system, with inefficient openings around High Street down to Solent Landing (Figure 8-4) and separately at Hillway. As a result, rather than surface water entering the highway drainage system, it followed the flow paths identified in the RoFSW mapping along the surface of the highway. It is noted, however, that highway drainage systems are normally designed for the 1 in 10 year rainfall event and therefore, if the entry points to the subsurface system had been more efficient, flooding could have occurred due to surcharging of the piped network.

Figure 8-4: Slot drain on High Street

Steyne Road/Lane End Road

The field at junction of Steyne Road and Hillway Road drains into the highway network through a 150mm diameter pipe which in turn drains to a 300mm carrier drain (Ordinary Watercourse consent application 22/00025/OWC). According to the drainage network drawings provided for this investigation by Island Roads, it appears that the highway drainage network connecting Steyne Road to the discharge point at Fisherman's Walk is separate from the adopted sewer network. However, without additional information regarding the highway drainage network and potential capacity issues, it is not possible to ascertain the extent to which highways drainage was blocked or undersized during the flood event.

Therefore, blockage and exceedance of the highway drainage network is understood to have contributed to the flooding experienced during the 28 – 29 June 2021 event, with drainage inhibited by material washing into the highway network.

8.2 Pathway

Figure 8-2 demonstrates the pathways of the water during the flood event on the 28 to 29 June 2021. The Risk of Flooding from Surface Water map (Figure 4-2) identifies surface water flow routes and areas of ponding which reflect the flood pathways. In this pathway, roads, footpaths and gardens act as conduits for the flood water.

There were four main pathways in the Bembridge area. This included the High Street down to Solent Landing/Station Road; Steyne Road to Lane End Road; pathways from Bembridge Down to Longlands Farm and in a south westerly direction along Hillway Road. The source-pathway-receptor overview for the 28 to 29 June 2021 event is shown in Figure 8-2 below. Flow paths are separated into primary pathways, where reported and modelled flood information provides a good evidence base, and secondary pathways which are indicated by modelled information but with limited alternative information.

The unadopted roads, and flow pathways during the 28 – 29 June 2021 event, adjoining Steyne Road and Lane End Road include:

- Heathfield Road
- Preston Road
- Manna Road
- Mitten Road
- Lane End Close
- Swains Lane

It has not been possible to include detailed investigations of all flooding locations, for example Meadow Drive and Woodland Grove where single reports with limited information were received. At Long Barn, where flooding was reported on two occasions, it is believed that the flow pathway was the same for both events.

High Street/King's Road/ Station Road/ Solent Landing

Figure 8-5 depicts the primary flow path down High Street which flowed past and flooded The Old Village Inn pub (location 1). Picture A shows the upstream view of flow path and picture B shows the downstream view of flow path.

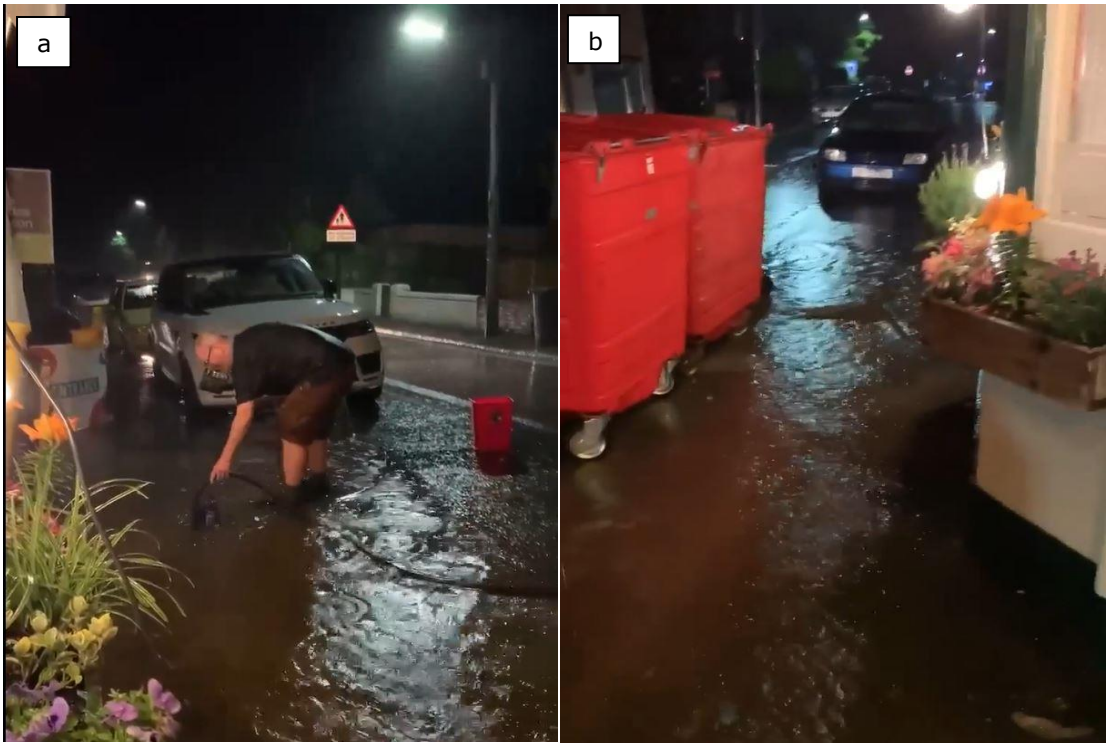

Figure 8-5: Location 1, The Old Village Inn, High Street

During the 28 – 29 June 2021 event, the surface water flow pathways followed the topography of the land from the top of High Street to Solent Landing. There were also secondary flow paths contributing to the flooding from High Street to Solent landing. These included Dennet Road, Pump Lane and Station Road as well as footpaths between King's Road and Station Road as shown in Figure 8-6 (location 2), following the steep topography which slopes to the north at this location.

Figure 8-6: Location 2, footpath between Kings Road and Station Road.

Surface water flowed northwards from High Street down Church Road and Sherborne Street to Kings Road which was described as "a river" by a local resident. The surface water then followed the steep topography, converging with surface water flows from Pump Lane to the south west at the Pilot Boat Inn. The joint surface water flow path then continued towards Beach Road; Solent Landing; Station Road and Harbour Strand (Figure 11-6) where it contributed to flooding of residential properties.

Steyne Road/ Lane End Road

Water flowed northeast from Sandown Road, southeast from Mill Road and north from Hillway Road, converging at the roundabout (location 1) and flowing northeast down Steyne Road (Figure 4-3). There were multiple secondary flow paths joining onto Steyne Road.

Some of these roads are effectively gravel tracks, causing a large amount of sediment and gravel to be washed down Steyne Road. The adjoining unadopted roads include Heathfield Road, Preston Road (Figure 8-7), Manna Road, Mitten Road (Figure 8-8), Lane End Close and Swains Road. The water continued to flow northeast from Steyne Road to Lane End Road and then to Bembridge Lifeboat Station (Figure 4-4).

Figure 8-7: Location 3, Preston Road

Figure 8-8: Location 4, Mitten Road

Longlands Farm

The Risk of Flooding from Surface Water (RoFSW) mapping indicates that Longlands Farm would be included within a flow route, based on the topography of the area. The average slope from the top of Bembridge Fort to Longlands is 1 in 5 with a drop of 82m and a sheer cliff face at the bend in the road at the site of the disused quarry. Given the intensity of the rainfall in the event, and the existing wet soil conditions, it is unlikely that infiltration of all rainfall would have been possible for this event. Multiple primary flow paths surrounded Longlands Farm during the June 2021 event (Figure 11-8). Evidence of flow routing at Longlands Farm is indicated by the presence of a ditch and culvert, and it is understood that works have been carried out since the flooding occurred to improve the conveyance of flows past the Longlands Farm House.

Hillway

RoFSW mapping shows surface water is predicted to flow down Hillway Road in a south westerly direction, following the steep slope of the road away from the ridge between the centre of Bembridge and Hillway. It is not clear whether of bank flooding occurred from the ditch and whether there was any interaction between the flow paths on the road surface. Accumulated surface water flows from Hillway Road would have then entered the ordinary watercourse, and have been conveyed in a northerly direction through the Whitecliff Bay caravan park, where anecdotal information suggests that flooding may have occurred to the touring pitches.

Historic Ordnance Survey mapping from 1866 indicates that a watercourse or ditch has been present at this location for over 150 years. Mapping from this time indicates that the watercourse ran parallel to Hillway Road in an open watercourse and has subsequently been culverted beneath the highway. Data from Island Road shows the culvert location although the diameter of the culvert is unknown. It is therefore likely that the rainfall event exceeded both the capacity of the ditch system and the section culverted under the road, as well as the highway drainage system in Hillway Road which is extremely steep at this point. Convergence of flows led to flood depths in excess of 200mm at the lowest point on Hillway Road.

8.2.1 Additional (secondary) pathways

A secondary flow path may have formed along Love Lane and Tyne Walk, as shown in Figure 8-2. Flooding was reported on Love Lane at the transition from highway to bridleway, and property flooding may have occurred although no additional information regarding the flood mechanism at this location was provided. In addition, no reports of flooding were received from Tyne Walk, where the RoFSW mapping indicates that flooding may have occurred. The single report of flooding in Meadow Drive is believed to relate to foul water, suggesting exceedance of the public sewer. It is therefore possible, but not conclusive, that the convergence of surface water flows from Tyne Walk and Love Lane followed the preferential flow route to the coast with the possible addition of flows from the surcharged sewer.

8.3 Receptors

8.3.1 People

Flooding has had a detrimental impact on the residents of Bembridge and their wellbeing. Responses from the stakeholder engagement survey and reports from Island Roads describe the stress and impact on mental health caused by the flooding.

A major impact of the flooding has been the disruption to daily life experienced by the residents. Residents have been displaced from their homes and housed in rented accommodation. For example, one property has been uninhabitable for three months and repairs are estimated to take a further six months. Some residents were unsure where they could go, needing to consider their businesses and ability to work. Displacement and uncertainty have caused stress and anxiety.

In some locations, foul water has entered properties, also causing a great deal of distress and damage. Flood water has damaged and contaminated carpets, floorboards, walls, furniture and belongings within the ground floor of properties. The damage to the ground level rooms has meant that many have lost the use of their kitchens, utility rooms and garages. Residents have had to pay for new appliances and spend time cleaning up the mess caused by the flooding.

Financial issues have also been experienced. Flood damage to affected properties has been estimated to have costed between £11,000 to £100,000. The added pressure and financial implications of dealing with insurers, builders and lawyers is also impacting the wellbeing of residents, causing stress and frustration.

Some properties on Steyne Road had historically flooded and this brought back memories and distress from past instances of flooding and sandbags were seen outside of houses in the Harbour Strand area during the site visit in December 2021, some six months after the June 2021 flood. Many property owners also raised concerns about future development in Bembridge and potential for increased flooding as a result.

8.3.2 Property

Between 28 to 29 June 2021, internal flooding to 10 residential properties and two non-residential properties was recorded (including non-habitable areas such as garages and utility rooms). Responses to the survey and information provided by the emergency services imply that the flooding in 28 – 29 June lasted for around five hours. However, in some locations flood water took up to 10 hours to retreat. Flood depths reached between 50mm to 300mm inside the properties and up to 600mm externally and within property garages. The Old Village Inn was one of the affected commercial properties, and Island Roads pumped out 24,000 litres of water from inside.

In locations with lesser flooding, properties took one week to dry out after the storm event. However, many took much longer, with some properties needing extensive repairs which are still ongoing. Properties experienced surface water flooding which entered gardens, garages and ground floor rooms causing huge amounts of damage. Additionally, at least two properties experienced internal foul water flooding during the event, with more experiencing foul water flooding in gardens and on roads.

It is unlikely that the internal flooding at Harbour Strand and Solent Landing occurred in habitable areas. Properties at Harbour Strand and Solent Landing are in tidal Flood Zone 2. Based on the site walkover, properties on Harbour Strand and Solent Landing appear to have been constructed with raised finished floor levels for habitable areas based on the risk of tidal flooding and have storage areas and garages underneath the properties. Nevertheless, residents at these locations would have been unable to leave their properties and properties at Solent Landing suffered flooding to stairways up to their living areas. In both cases, loss of contents occurred in storage areas.

8.3.3 Infrastructure

The local road network was flooded during the 28 – 29 June 2021 event, but no other infrastructure was reportedly affected. The flooding did not result in any road closures by Island Roads, however flooding to the following roads was reported in this event:

- Embankment Road
- Beach Road
- Harbour Strand
- Station Road
- Kings Road
- High Street
- Church Road
- Sherbourne Road
- Foreland Road
- Woodland Grove
- Tyne Walk/Love Lane
- Hillway Road
- Sandown Road
- Mill Road
- Steyne Road
- Lane End Road
- Heathfield Road
- Preston Road
- Manna Road
- Mitten Road
- Swains Road

8.3.4 Services

The flooding led to the closure of local businesses at a time when they were vulnerable to the economic impacts resulting from the COVID-19 pandemic.

The Old Village Inn pub had been refurbished just before the June 2021 flood event, and was forced to close and be refurbished again due to the damage caused by flood water.

The flooding led to the temporary closure of one known commercial unit in Weavers Yard on Lane End Road for four days and further disruption for eight weeks whilst extensive repair works were carried out. Furniture damaged by the water had to be disposed of and the whole unit needed refurbishment. This caused inconvenience to clients, loss of income and a large amount of stress. It is possible that flooding to other units occurred at Weavers Yard, however, no further information was received in the consultation exercise.

Bembridge is known as a holiday destination and some of the properties (particularly towards the coast) are used as short-term letting accommodation. This is likely to have led to a loss of income whilst flood recovery works were being undertaken. At Hillway, anecdotal information from visitors to the Holiday Park suggests that flooding may have occurred to some of the touring fields during June and July 2021.

9 Capacity review

9.1 Review of sewer network

A review of Southern Water sewer network data indicates that most of the sewers in the village centre are foul sewers, including from High Street to Station Road, and there are a limited number of surface water sewers. Southern Water has also stated that many of the sewers listed as foul may be combined sewers, taking foul and surface water, but they have no data to support or change the current assumption. For the purposes of this investigation, it is therefore considered that foul sewers are also combined sewers, unless there is a separate surface water sewer in the same road.

Figure 9-1 shows assumed combined sewers in the village centre, as well as parts of the highway drainage network. The information on the highway drainage network is not complete, particularly regarding pipe locations and diameters, although a comprehensive record of the location of highway gullies was provided.

The northern end of Kings Road, Station Road and Solent Landing have separate surface water drainage networks for the highway.

The sewer system along Steyne Road is shown to be combined (as shown in Figure 9-2) and the highway drainage system also appears to discharge to the combined sewer network.

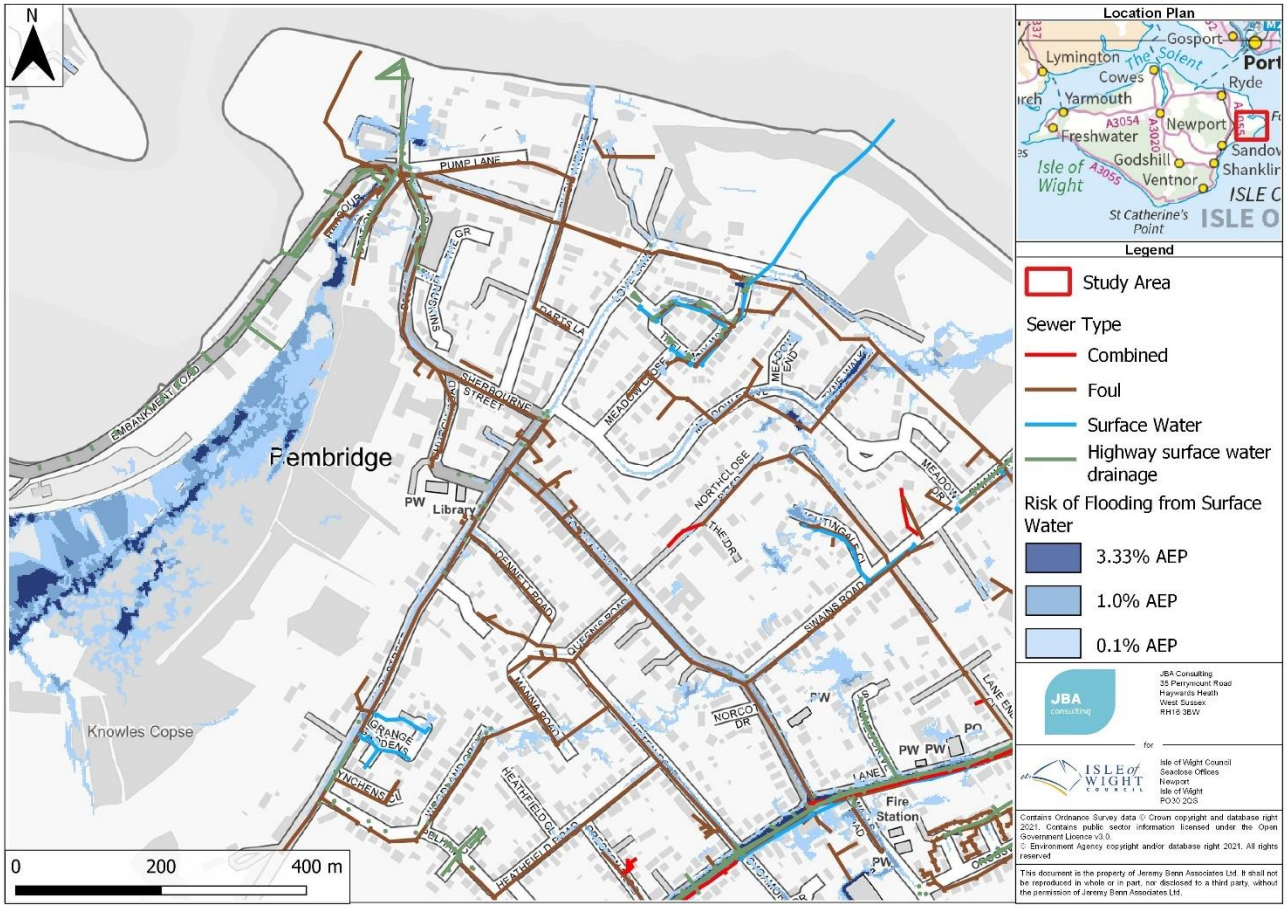

Figure 9-1: Sewer network and highways drainage around High Street

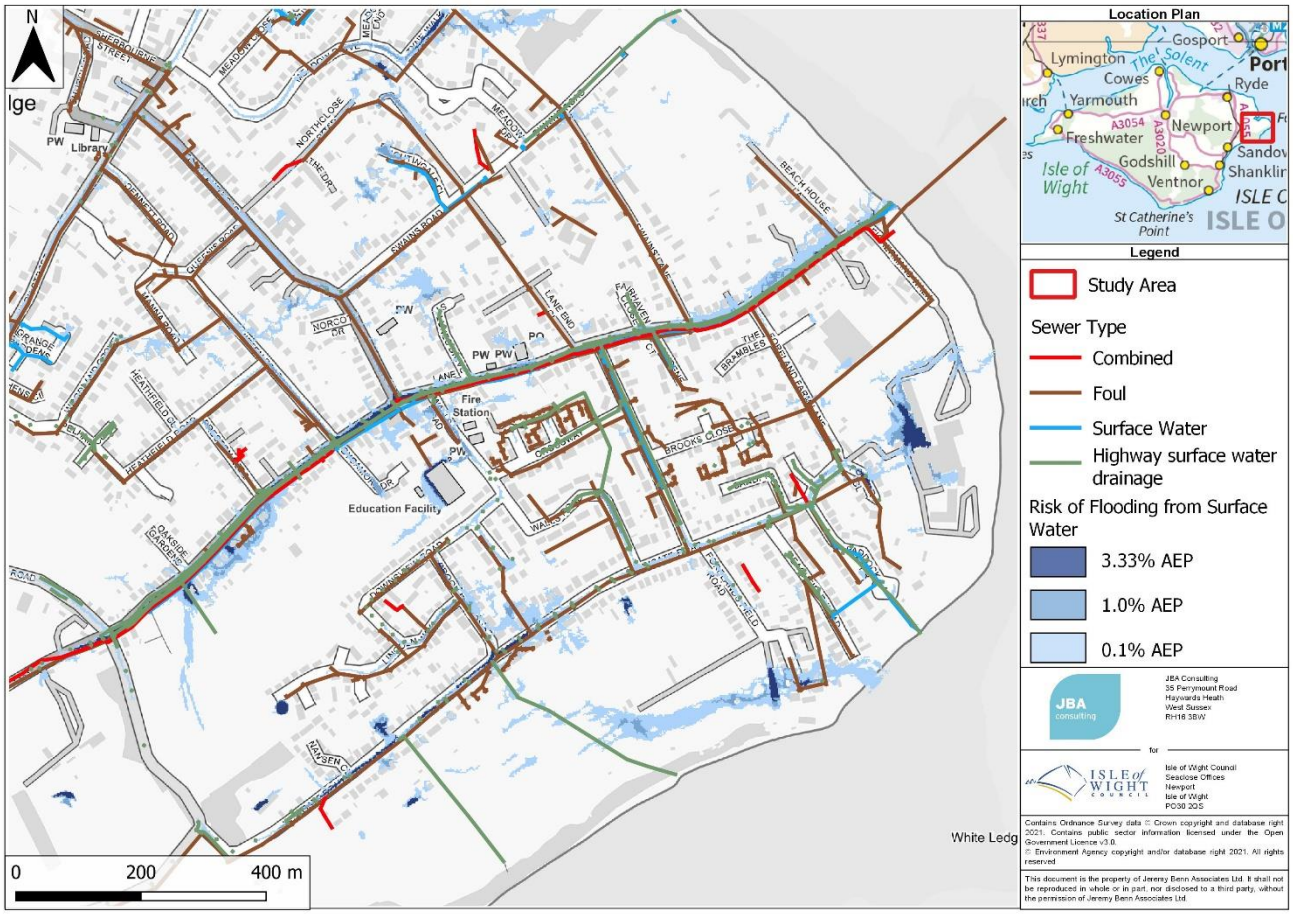

Figure 9-2: Sewer network and highways drainage around Steyne Road

9.2 Review of capacity

Information from Southern Water indicates that there have been previous reports of surface water drainage issues in Bembridge. However, further details regarding the nature of these issues were not available. A list of roads in Bembridge with historic drainage capacity issues has also been provided by Southern Water, this includes:

- Station Road (1998-2021)
- Steyne Road (2021)
- Hillway Road (2010-2013)
- High Street (2021)
- Mill Road (2021)

Potential capacity issues on Steyne Road were reported six times in 2021 including on 29 June 2021, with issues also reported at Hillway and Mill Road.

One potential capacity issue was also reported on High Street and another on Kings Road on this date. Responses to the stakeholder survey indicate that flood water during the 28 – 29 June 2021 event contained foul sewage, which also suggests that the flooding occurred from the combined sewer system.

The **Design and Construction Guidance**[12] for foul and surface water sewers has been reviewed to determine typical sewer design standards. This indicates that modern surface water sewer systems are designed to convey flows from 1 in 30-year rainfall events without flooding. It should be noted that these are present day design standards and the older combined surface water sewer systems in Bembridge would not have been designed to meet these design standards. In the future, climate change will mean that more intense storms will become more common, effectively reducing the design capacity of the sewers.

9.3 Conclusions

As outlined in Section 6.2, the rainfall event on the 28 to 29 June 2021 had an annual probability between 2% and 5% (between a 1 in 50-year and a 1 in 20-year storm event) which is in excess of the highway drainage design capacity. Southern Water also reported capacity issues in the public sewer network and residents reported the presence of foul sewage in flood water on High Street, Harbour Strand and Solent Landing, in two cases entering residential properties. It can therefore be concluded that hydraulic overload of the sewer system occurred during the event, with surface water entering the sewer system and mixing with effluent from the combined sewer network. Diluted foul flood water likely emerged from the system at surcharged manholes within Bembridge village, and the two CSOs at Bembridge Point and Lane End Road were utilised for a prolonged period. A large volume of surface water was reported to have flowed down Steyne Road and adjoining roads, suggesting that the capacity of the highways network and/or combined sewer system along Steyne Road had been exceeded.

The mechanisms of flooding at Hillway and Long Barn were different to those within the village centre. At Hillway, surface water accumulated at a localised low spot leading to high water depths and at Long Barn, surface water flow paths were established on the steeply sloped face of the chalk. However, the source of the flooding was still ultimately the high intensity of rainfall which occurred overnight on 28 – 29 June 2021.

12 Design and Construction Guidance (Appendix C): https://www.water.org.uk/wp-content/uploads/2020/03/SSG-App-C-Des-Con-Guide-v-2-100320-C.pdf

10 Discussion, appraisal and recommendations

10.1 Introduction

Responses to the stakeholder engagement survey indicate that there was no one central point of flooding in Bembridge for the flooding that occurred on 28 – 29 June 2021. However, it has been identified that all properties flooded as a result of surface water runoff, which in some locations mixed with effluent from the foul sewer network to cause foul flooding. At Hillway it is possible that groundwater emerged at a spring line at the base of the chalk.

A high-level options appraisal was undertaken to identify and screen recommendations detailed in this report. This appraisal process included a multi-criteria analysis to compare options. The analysis considered the relative contributions of each option towards:

- reducing flood risk to property
- reducing flood impacts on people/communities
- improving the availability of data, evidence and modelling to support option development or flood incident response
- biodiversity and water quality betterment
- amenity benefits
- carbon reduction

The following elements were also included to include practical considerations in the assessment:

- Maintenance requirements
- Community / resident acceptability
- Deliverability (including construction complexity, access, designations, services, space, land ownership, available materials and expert equipment or advice required)

Relative costs and timescales have been provided for information only and are not included in the scoring. The scoring criteria and full results are described in more detail in **Appendix C**. Options with a score of 7 or above were taken forward to become recommendations, however it is noted that some of the other options may also be favourable due to cost or timescale implications which have not been included in the weightings.

It is important to note that this is a high-level, preliminary assessment undertaken by and on behalf of Isle of Wight Council. Therefore, it is for the relevant responsible body or persons to assess these recommendations in terms of their legal obligation, resource implications, priority and the costs and benefits of undertaking such options. Where taking forward a recommendation is likely to be reliant on securing grants from central government to fund the project[13], significant further work by the responsible organisation will be required to assess the costs/benefit of the proposals, and consideration will need to be given to the timing and availability of funding. This is likely to be the case for the recommendations within this section. For such projects to be taken forward to design and construction, a business case may need to be made into a national programme, with the success of the bid dependent on the following:

13 For further information regarding funding of flood risk management, please see: https://www.local.gov.uk/topics/severe-weather/flooding/paying-flood-and-coastal-erosion-risk/funding-arrangements

- Any works are cost beneficial and financially viable
- The works will provide a sufficient level of benefit for the residents at flood risk
- Any project has considered all sources of flood risk
- The project does not increase flood risk to others (people, property, business)
- The works do not cause environmental harm
- Any proposals are accepted by the community and residents

Based on the identified causes and mechanisms of flooding, we have considered the following options.

10.2 Surface Water Management Plan

The drainage network for Bembridge is complicated, with highway drainage networks and adopted sewers interacting in some areas but seemingly separate in others. Southern Water have publicly stated their wish to improve drainage infrastructure and reduce CSO discharges through their **Surface Water Storm Overflows taskforce**. It is understood that the first stage in their three-stage approach is to understand the Island sewage system. To date, Island Roads (on behalf of the Highway Authority) have not provided an indication as to future works planned in Bembridge. We understand that parts of the system are mapped with good understanding of gully locations, but the interactions between different parts of the network is not clear.

One possible avenue to fully understand the drainage network in Bembridge would be to undertake modelling of the entire system through a Surface Water Management Plan led by the Lead Local Flood Authority. These are non-statutory plans and according to DEFRA guidance, *they should be prioritised in areas considered to be at greatest risk of surface water flooding or where partnership working is considered essential to both understand and address surface water flooding concerns.* They can also *become an opportunity to address long-standing problems through strategic improvements and upgrades to the drainage system and to ensure surface water runoff from the developed site is reduced in comparison with existing runoff.*

Further guidance on SWMPs is available online.

There is a linkage between the SWMP and Local Development Framework, and therefore Outputs from the SWMP study can be used in the Sustainability Appraisal of a Core Strategy, or other Development Plan Documents, to provide evidence, sustainability objectives and indicators. It is, however, noted that it may not be possible to include the outputs from a SWMP in the current planning cycle.

It is noted that this would require investment and input from multiple RMAs, including Southern Water, the Highway Authority and the Lead Local Flood Authority, however some of the required data may be held by the relevant authorities and a partnership approach could lead to improved management of the system and cost-savings on data collection in the long term.

10.3 Local community preparation and resilience measures

The village of Bembridge is at risk of multiple sources of flood risk, as many of the low-lying areas around Station Road and Embankment Road are at risk of tidal, fluvial and surface water flooding. Although Bembridge does not currently have a Flood Action Group, the Parish Council provided a central source of information and guidance for the local community during the event and, following the flood event of 28- 29 June 2021, the Parish Council discussed the possible purchase of sandbags for the community. Parish Councillors have stated that sandbags were requested from Island Roads but were not situated within Bembridge and driving to the depot during this flood event would have been dangerous due to low visibility and flooded roads.

The local community may want to consider setting up a Flood Action Group, either through the Parish Council or as a separate entity. Through these 'grass-root' groups, communities can:

- Take ownership of flood risk issues within a community.
- Address their concerns over malfunctioning assets/and other issues.
- Utilise local knowledge to work with Risk Management Authorities suggest new and innovative ways of managing flood risk.
- Coordinate proactive and reactive works to private assets to reduce risk in the community.
- Provide a co-ordinated response to consultations on future flood risk management within the community.
- Raise awareness of flood risk to the wider community.
- Develop a community plan to prepare, respond and recover effectively to flood events.

Emergency flood packs may be created to use during a flood and once established, the group could apply for community group funding to purchase communal flood protections measures (such as sandbags, inflatable barriers etc). These can be deployed to areas at risk during an event, as well as to vulnerable residents who have difficulty collecting and carrying protection measures such as sandbags and flood boards.

Support for such groups can be found through organisations such as the National Flood Forum. Groups have been set up elsewhere across the Island (including in Ryde and Binstead) and have been an excellent tool in aiding the management of flood risk at a community level.

10.4 Reduce movement of gravel into highway drains

Many of the roads in Bembridge are unpaved and **unadopted**, with little or no formal highway drainage in place. As a result, surface water washes out the loose material of the road surface, which then enters the drainage system of the formal adopted highway. Washout of unadopted road surfaces was seen in the vicinity of the Station Road/Embankment Road junction, High Street and Steyne Road/Lane End.

Video and photographs show gravel washed into the adopted highway drainage network, and it is highly likely that the movement of gravel occurred during the 28 – 29 June 2021 flood event. It is possible that previous blockages in the gullies and highway network reduced the capacity of the network to accept surface water flows during and after the June flood event. CCTV survey files of the drainage network were not provided for this report, but it is understood that gravel was found in the drainage network at High Street.

Where roads are unadopted, there is no responsibility or funding for the Highway Authority to improve the road surface or drainage. However, the Highway Authority has powers under the Highway Act (1980) to take action to require the person(s) who deposited the nuisance to remove it. In Bembridge, this could mean that homeowners on unadopted roads (who have responsibilities for the road) would need to organise for gravel to be removed from the adopted highway if it washed on to adopted roads.

Remediation of these unadopted highways to anywhere near the adoptable standard would place a potential considerable cost burden to property owners and upgrading the drainage of the unadopted road network with an unrestricted piped network or impermeable surfacing may have unintended consequences, such as increasing the rates and volumes of surface water runoff which enter the existing adopted highway network. Therefore, stabilisation of the road surface, rather than the introduction of a full sub-surface drainage system, may be more pragmatic.

Without a formalised way of agreeing actions between homeowners on unadopted roads (frontagers), it is acknowledged that improvements will be difficult and possibly contentious. It is therefore suggested that, with support and guidance from the Highway Authority, frontagers could consider the following actions in the first instance:

- Formalising action for future maintenance of the road through a Community Interest Company or similar (likely to have greatest impact but hardest to implement)
- Form a community group to discuss and coordinate the future maintenance of the roads
- Undertake ad-hoc measures individually to stabilise the gravel for individual areas of responsibility (likely to have least impact but easiest to implement)

10.5 Property Flood Resilience scheme

Property Flood Resilience (PFR) can provide effective resistance and resilience to flooding at an individual property level. Measures such as flood doors, flood barriers, automatic airbricks and non-return valves can help to reduce the impact of future floods, by aiming to limit water entry (resistance). Alternatively, the internal fabric of the property can be adapted to limit damage when water enters (resilience).

Although resistance measures are not able to entirely prevent flood water ingress, they aim to limit damage and ensure properties are adapted to cope with the impacts of floods and recover quickly from these disruptive events. They are generally significantly lower in cost than resilient adaptation works to the property fabric itself, whereby flood water entering a property would lead to minor or no damage. While constraints of both approaches include funding, homeowner willingness and individual property structural risks, the lower cost and less invasive resistance measures will often meet business case cost/benefit approval for Government funding support for community schemes in areas where flood risk is high.

It should be noted that taking forward a Property Flood Resilience scheme at Bembridge is likely to be reliant on securing grants from central government to fund the project[14]. Further work will be required to assess the suitability of the properties for installation of Property Flood Resilience measures, costs/benefit of the proposals, and consideration will need to be given to the timing and availability of funding. Further investigation would also be needed to consider funding arrangements where properties act as a business (i.e., as a holiday let) or where non-habitable areas (i.e., storage areas) are at risk. Self-funded property Flood Resilience measures are commercially available to properties that do not meet the criteria for local or national government funding.

10.6 Improve gullies on High Street and interception into the drainage system

Many of the drainage gullies on the High Street in Bembridge are slot drains (locally called letterboxes) built into the kerbs. Video footage taken during the 28 – 29 June 2021 flood event showed the slot drains were unable to efficiently intercept the volume of surface water on the High Street during the event. The inclusion of additional gullies at the locations of the slot drains would increase interception of surface water so that surface water will be conveyed through the highway drainage network rather than on the road surface

In considering increasing the inlet capacity of the network, care must be taken to assess the capacity of the whole network, such that increasing the efficiency of the system upstream does not cause an increased risk of flooding downstream in the system.

10.7 Improved asset maintenance regimes

Island Roads has an annual maintenance schedule which includes jetting the gullies throughout Bembridge. However, given the amount of material observed washing into the gullies, increasing the frequency of gully jetting, particularly before forecast rainfall events, may help to maintain the ability of the gullies to intercept and convey surface water flows, as well as reducing the risk of blockage within the piped network.

14 For further information regarding funding of flood risk management, please see: https://www.local.gov.uk/topics/severe-weather/flooding/paying-flood-and-coastal-erosion-risk/funding-arrangements

It is understood that surface and subsurface road cleansing are covered by independent contracts. However, it is important that maintenance works are co-ordinated, so that gullies do not become blocked after surface cleansing.

In order to understand the maintenance requirements of the piped network, asset condition information needs to be routinely collected. Following the June 2021 flood event, Island Roads surveyed drainage runs on the High Street, and found a blockage of fat and some stone debris within the drainage network. As well as a routine survey schedule, it is also recommended that a survey of the network in Harbour Strand is undertaken (if not already carried out) to assess the condition of the pipe joining the ditch to the piped network at the Station Road junction. This would determine if there were any blockage of this pipe contributing to drainage capacity restriction at the junction.

10.8 Improved capacity of ditches on Mill Lane

Highway asset records Google Street view imagery from March 2021 show that Mill Lane is drained by a series of highway drainage ditches, running parallel to the highway. The purpose of the ditches is to remove surface water from the highway and provides some temporary storage of surface water. The drainage asset information provided by Island Roads does not indicate how water flows from the highway into the ditch, however in general terms, highway surface water can either be drained to ditches through "grips" which run diagonally into the ditch on the surface, or via a sub-surface network via gullies.

Once the details of the existing drainage and maintenance requirements are known, increasing the ditch capacity and the efficiency of water entering the ditch system on Mill Lane could reduce the volume of surface water flowing along the surface of Mill Road and therefore reduce flooding on roundabout at the top of Steyne Road, where flows from four roads (including Mill Road) converge.

10.9 Appraise the feasibility of providing upstream flood attenuation

Incorporating flood storage upstream of the affected properties could slow down surface water flows and reduce the impacts of flooding in the Bembridge area. This could include the use of Sustainable Drainage Systems (SuDS) such as rain gardens, basins, permeable surfaces, or underground storage tanks with controlled outlets, to intercept and temporarily store flows during extreme events, reducing the impact of these events on existing drainage systems.

Development offers one way of mitigating current surface water flood risk through on-site measures that would otherwise be unlikely to be economically viable on their own or delivered. In all cases, new development must follow the principles of draft planning policy EV14 (use opportunities provided by new development to reduce the causes and impacts of flooding and manage residual risk). Early engagement between developers and IoW council as the LLFA could add significant value in determining how development could reduce the risk of flooding on-site and in the surrounding area. Reduction of off-site flood risk through new development (rather than merely not increasing flood risk) could also improve the acceptability of proposals to the communities in which they are located.

The RoFSW mapping and reports of flooding on Steyne Road and Lane End indicate that flooding occurred on 28 – 29 June 2021 despite works by Island Roads to increase the capacity of their drainage network by upgrading the network with larger diameter pipes. As the rainfall during the June 2021 event had an annual probability of between 2% and 5%, it is considered to be a significant flood, but in the future events like this will become more frequent due to climate change.

Upstream storage in open land, particularly where uncontrolled ponding is already occurring, would reduce the peak runoff and volumes of runoff entering the highway drainage system. It could also provide water quality, biodiversity and amenity benefits, if blue-green infrastructure is

provided. It is recommended that adjacent property owners are consulted at an early stage on any proposals where SuDS infrastructure is proposed in close proximity to property boundaries, to address any concerns at an early stage in the design process. SuDS scheme should also consider ownership and maintenance requirements for the lifetime of the development it serves, including funding arrangements for future maintenance.

10.10 Increased sub-surface drainage capacity at critical hotspots

Capacity restrictions within the highway drainage network and adopted sewer network were recorded during the 28 – 29 June 2021 event. This was to be expected, as the rainfall event exceeded the design capacity of either network. Due to the presence of a combined sewer system in Bembridge, carrying foul and surface water flows, foul flooding is a particular concern in Bembridge. Southern Water has committed to reducing usage of CSOs through a dedicated taskforce. This provides a good opportunity to consider the hydraulic overloading of the combined sewer network from surface water, and explore options to increase drainage capacity, or disconnection of surface water from the combined system, for example through the use of SuDS.

10.11 Extension of highway drainage infrastructure at High Street/Mill Road

Based on data provided by Island Roads, there appears to be limited sub-surface highway drainage at the junction of High Street and Mill Lane. As such, surface water from the Bembridge windmill area is routed down Mill Lane and Sandown Road. Extending the existing drainage network, either through the provision of drains or ditches, could reduce the volume of surface water routed on the road surface. Extension of the drainage network upstream would require consideration of downstream impacts on the capacity of the existing network which may result in a requirement to upgrade the existing system.

10.11.1 Introduction of drainage and SuDS Supplementary Planning Document

Supplementary Planning Documents (SPDs) build upon and provide more detailed advice or guidance on policies in an adopted local plan. As they do not form part of the development plan, they cannot introduce new planning policies into the development plan but do not necessarily need to align to the Local Plan submission timeline. They are, however, a material consideration in decision-making.

Supplementary Planning Document (SPD) provides guidance for developers on what is expected of them as they bring sites forward. It is essential that the management of water is considered at the earliest stage of a development. The SPD would be designed to aid in the planning, design and construction of new developments across the Isle of Wight, setting out the specific detail and information required by the Council to determine the suitability of a development proposal in respect of sustainable surface water management. A drainage and SuDS SPD would provide a robust framework to allow the Council to deliver effective SuDS which manage surface water runoff.

10.11.2 Update to Bembridge neighbourhood plan to include drainage and surface water management policies

The Bembridge Neighbourhood Development Plan 2014 covers the whole of the Parish of Bembridge. It has equal weight to the Local Plan in the plan area and therefore is a material consideration in the determination of planning applications. The plan must be in alignment with the Island-wide strategy which is currently being updated. However, the Neighbourhood Plan can include policies that are specific to the requirements of Bembridge, and the timing of the plan can differ to that of the Island-wide strategy. It would therefore be possible for an update to the neighbourhood plan to include drainage and surface water policies for new development which would consider the specific difficulties for surface water drainage in Bembridge.

As new development still has the right of connection to the adopted network, it is recommended that the LLFA, Island Roads (on behalf of the Highway Authority) and Southern Water are involved in the formulation of new drainage policies for the neighbourhood plan.

11 Conclusion and recommendations

11.1 Conclusions

The flood events of 28 - 29 June 2021 in Bembridge Parish cause internal flooding to 12 properties throughout the village of Bembridge. At least one property outside of the village centre was internally flooded in this event and again a month later. It is possible that flooding occurred to more properties where records were not submitted as part of the call for information. Multiple dates of flooding were submitted and therefore an analysis of rainfall on different dates was undertaken to determine the likelihood of flooding on those dates. Further investigation determined that the most severe flooding took place on 28 – 29 July 2021.

This report has identified that a severe rainfall event caused surface water runoff above the design capacity of the highway drainage and sewer networks, with an annual probability of between 2% and 5% (between 1 in 50-year and a 1 in 20-year return period). The steep topography of Bembridge, along with a lack of a formal highway drainage system in several areas of Bembridge, resulted in surface water flowing along preferential pathways such as Steyne Road, High Street, Hillway Road and Kings Road. Internal flooding to property predominantly occurred at low points, with the notable exception of High Street.

The highway maintenance schedule received from Island Roads indicates that scheduled maintenance of the drainage systems had taken place prior to the flood event of 28 – 29 July 2021. Despite this, the photographic and video evidence provided suggests that the efficiency of the highway drainage system to intercept and convey flows was impeded by narrow in-kerb slot drains and blockages in the sub-surface drainage system. It is therefore likely that gravel washed into the drainage system during the event contributed to the flooding and is particularly likely to have exacerbated flooding on the High Street.

Information provided by Southern Water, and publicly available information on CSO discharges, indicates that the adopted wastewater network in Bembridge is a combined system and therefore susceptible to foul flooding in a surface water rainfall event. Reports of foul flooding and the prolonged discharge from the CSO, as well as information provided directly by Southern Water, indicates that hydraulic overloading of the sewer system happened during this event. This would have been expected, due to the rainfall event exceeding the design capacity of the sewer system.

The responses from the stakeholder engagement survey describe the stress and impact on mental health that the flooding has caused. Residents are stressed about future flooding events, resulting in anxiety, depression and loss of sleep. Evidence of sandbags outside of houses was seen during the site visit in the Harbour Strand area, some months after the June 2021 flood.

A major impact of the flooding has been the disruption to daily life experienced by the residents. Whilst most residents were able to stay in their property, at least one resident had to move out of their home into alternative accommodation, and was still living in temporary accommodation nine months after flooding occurred. Carpets, floorboards, furniture, and belongings were lost from properties.

11.2 Recommendations

We undertook a high-level option appraisal focussing on benefit, practical and viability considerations. We carried out a multi-criteria analysis to compare each option which included consideration of relative costs and timescales, buildability, health safety and environment, stakeholder perceptions and public acceptability, land ownership etc. This was used to develop recommendations to mitigate flood risk in the Bembridge area.

The conclusions on which recommendation to consider taking forward are presented below, based on the results of the multi-criteria analysis. The full list of assumptions and criteria used in this assessment are provided in Appendix C.

The long list options which scored the highest were developing a Surface Water Management Plan for Bembridge, implementation of a Property Flood Resilience scheme and appraising the feasibility of providing upstream flood attenuation. Whilst recommendations are based on a threshold score of 7, it is noted that the scoring is based on the overall benefit of the scheme and it may be that other actions, whilst not providing the same level of benefit, may be more achievable due to time constraints and the complexities of delivery.

Table 11-1: Recommendations from Bembridge S19 investigation

Recommendation	Organisations(s) responsible	Multi-criteria analysis score	Timescale
Surface Water Management Plan	LLFA	7	1-5 years
Property Flood Resilience scheme	LLFA/ Residents	7	<1 year
Appraise the feasibility of providing upstream flood attenuation	LLFA	7	1-5 years

Appendices

A Risk of Flooding from Surface Water maps

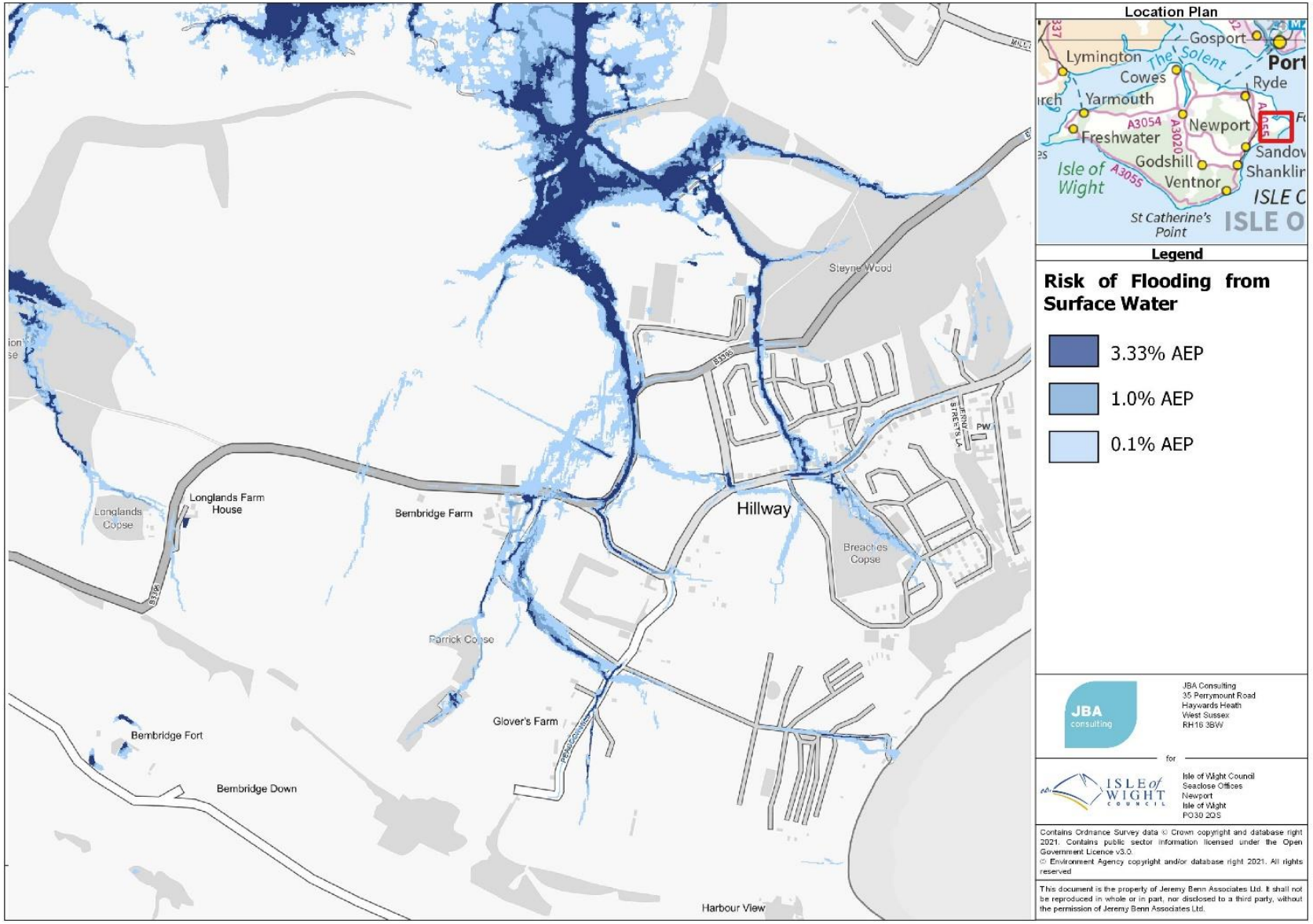

Figure 11-1: Risk of flooding from surface water in Hillway and Longlands Farm

(Annual exceedance probability (AEP) refers to the probability of a flood happening in any one year)

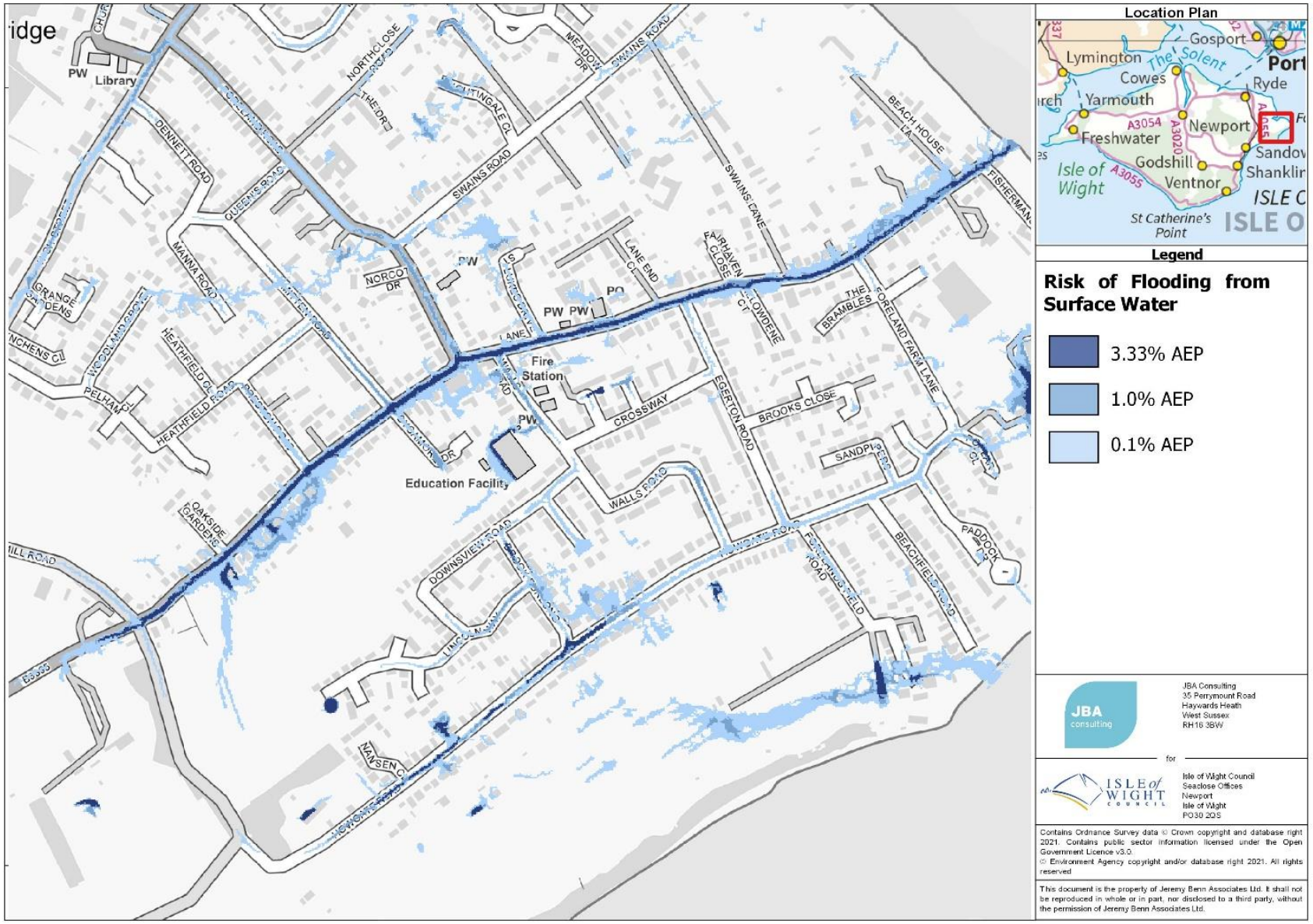

Figure 11-2: Risk of flooding from surface water from on Steyne Road

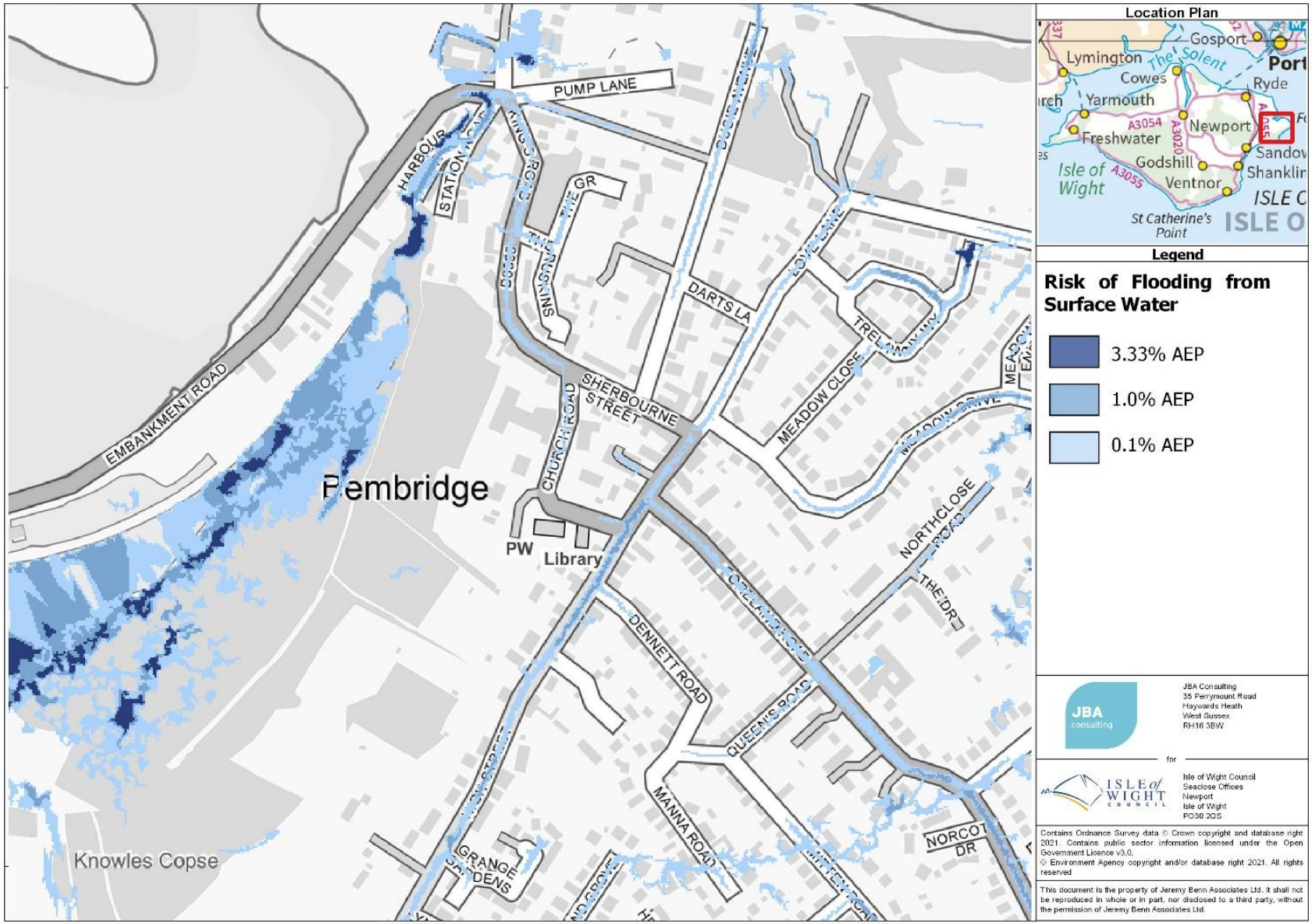

Figure 11-3: Risk of flooding from surface water from High Street to Solent Landing

B Source-pathway-receptor analysis maps

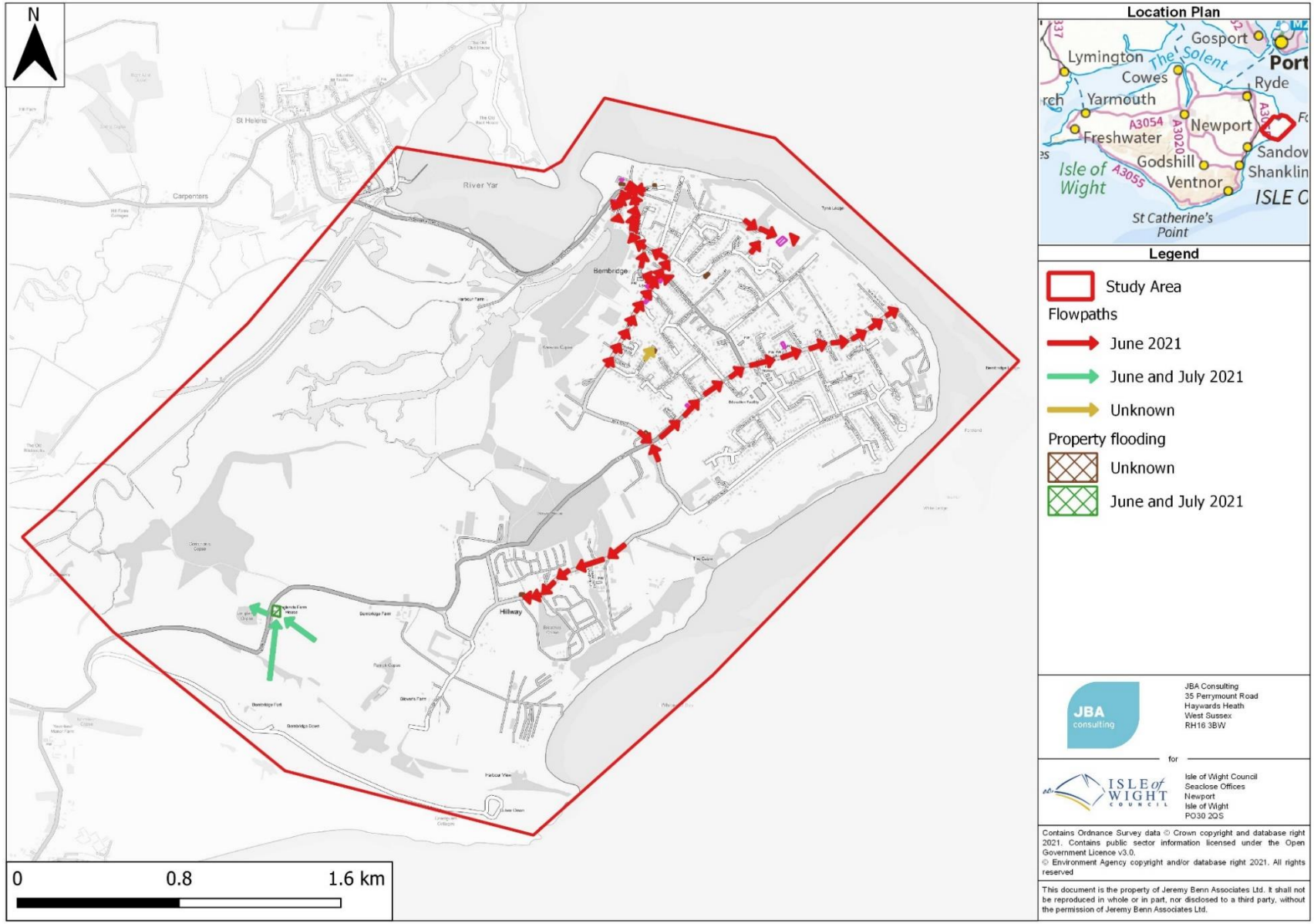

Figure 11-4: Overview of sources, pathways and receptors 28-29 June and 27 July 2021

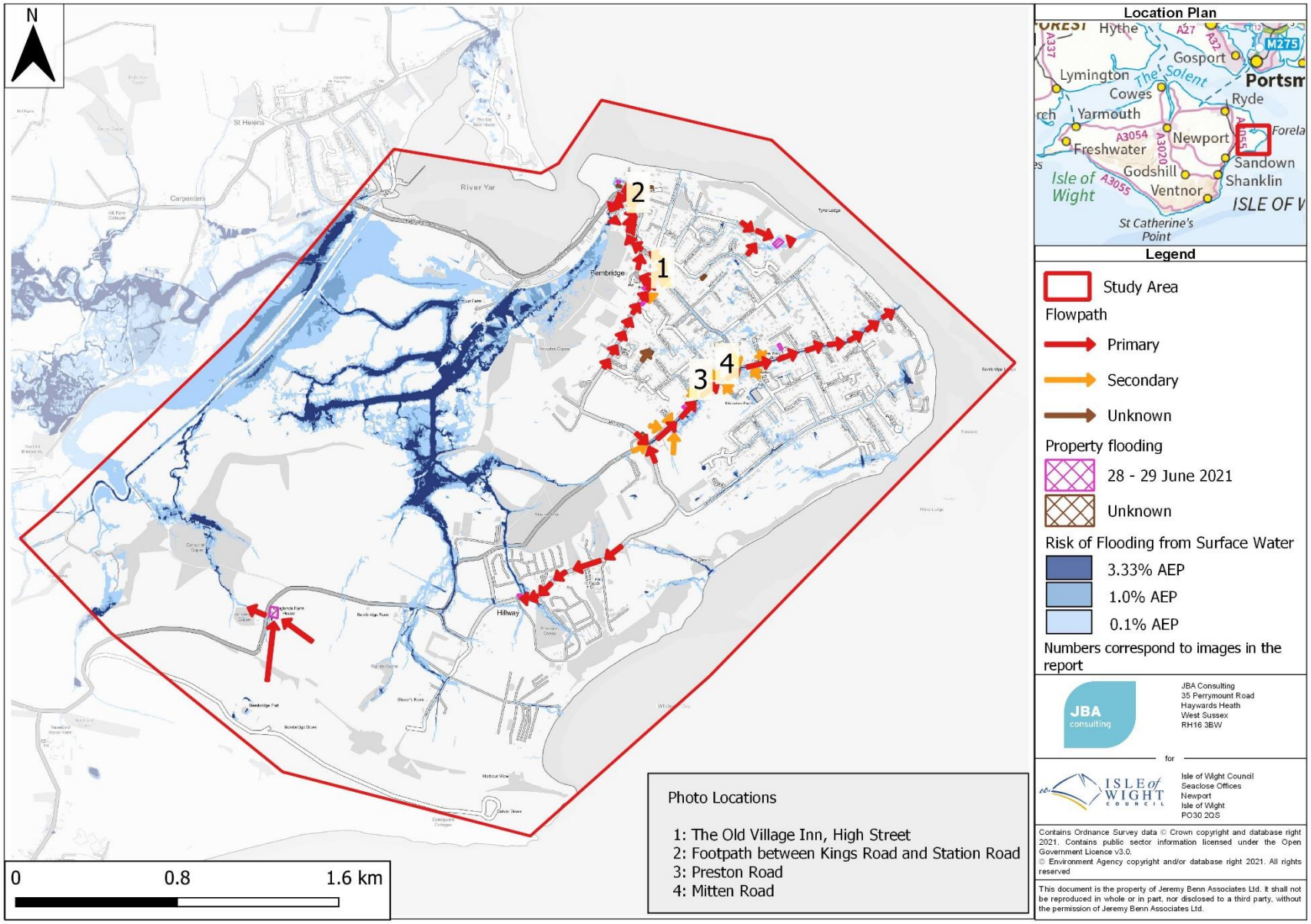

Figure 11-5: Photo locations 28-29 June 2021

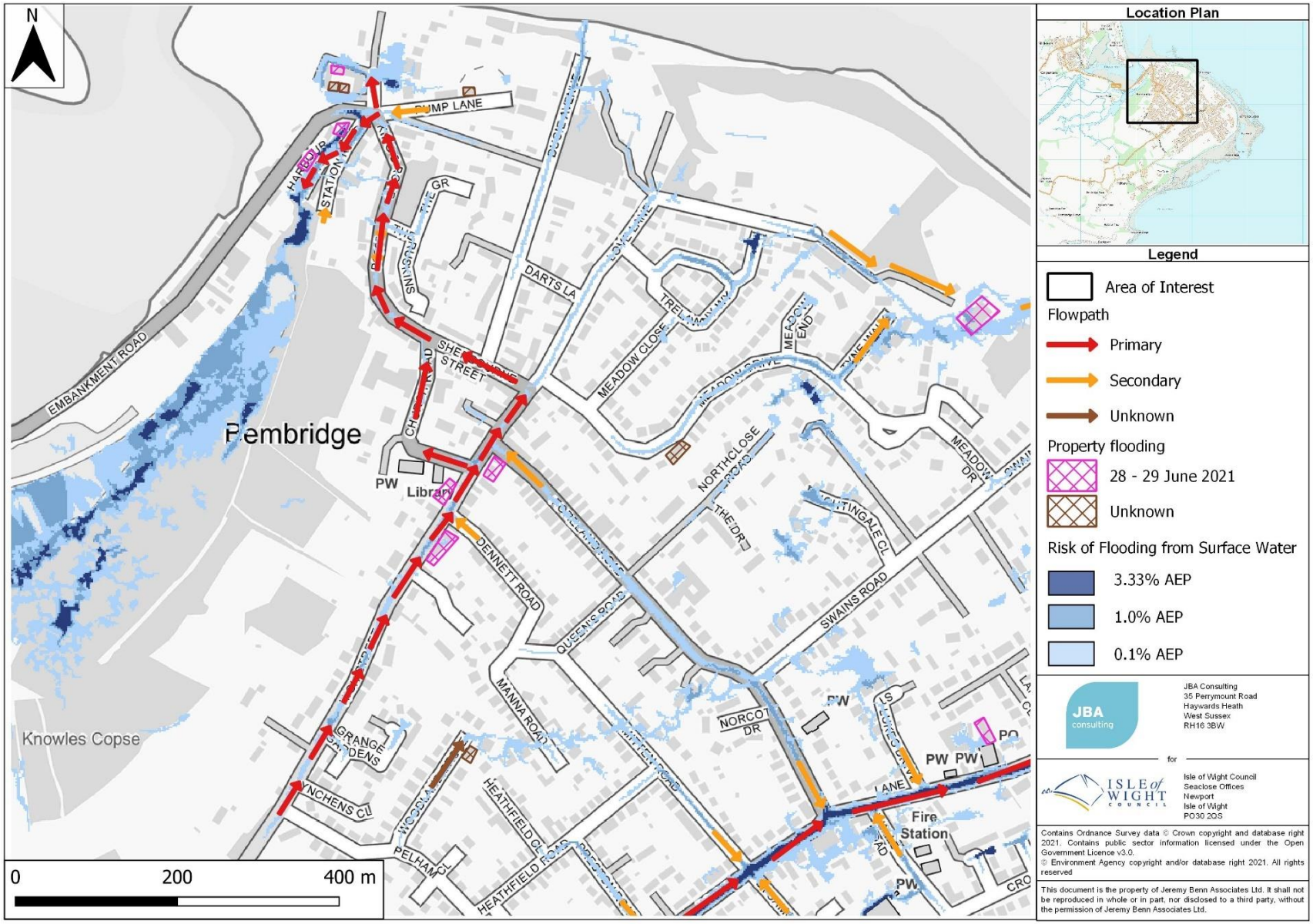

Figure 11-6: Sources, pathway and receptors - High Street to Solent Landing

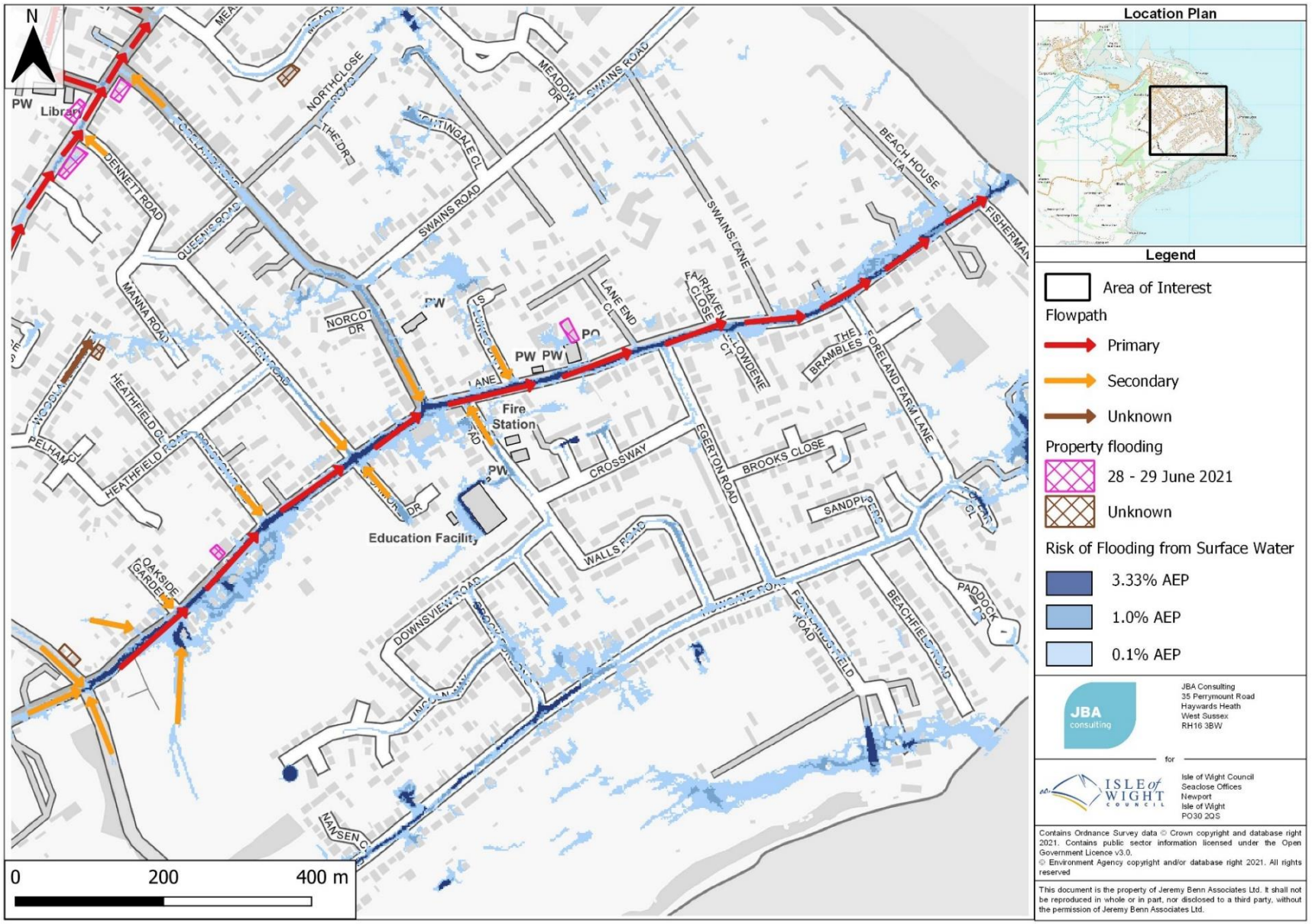

Figure 11-7: Sources, pathway and receptors - Steyne Road

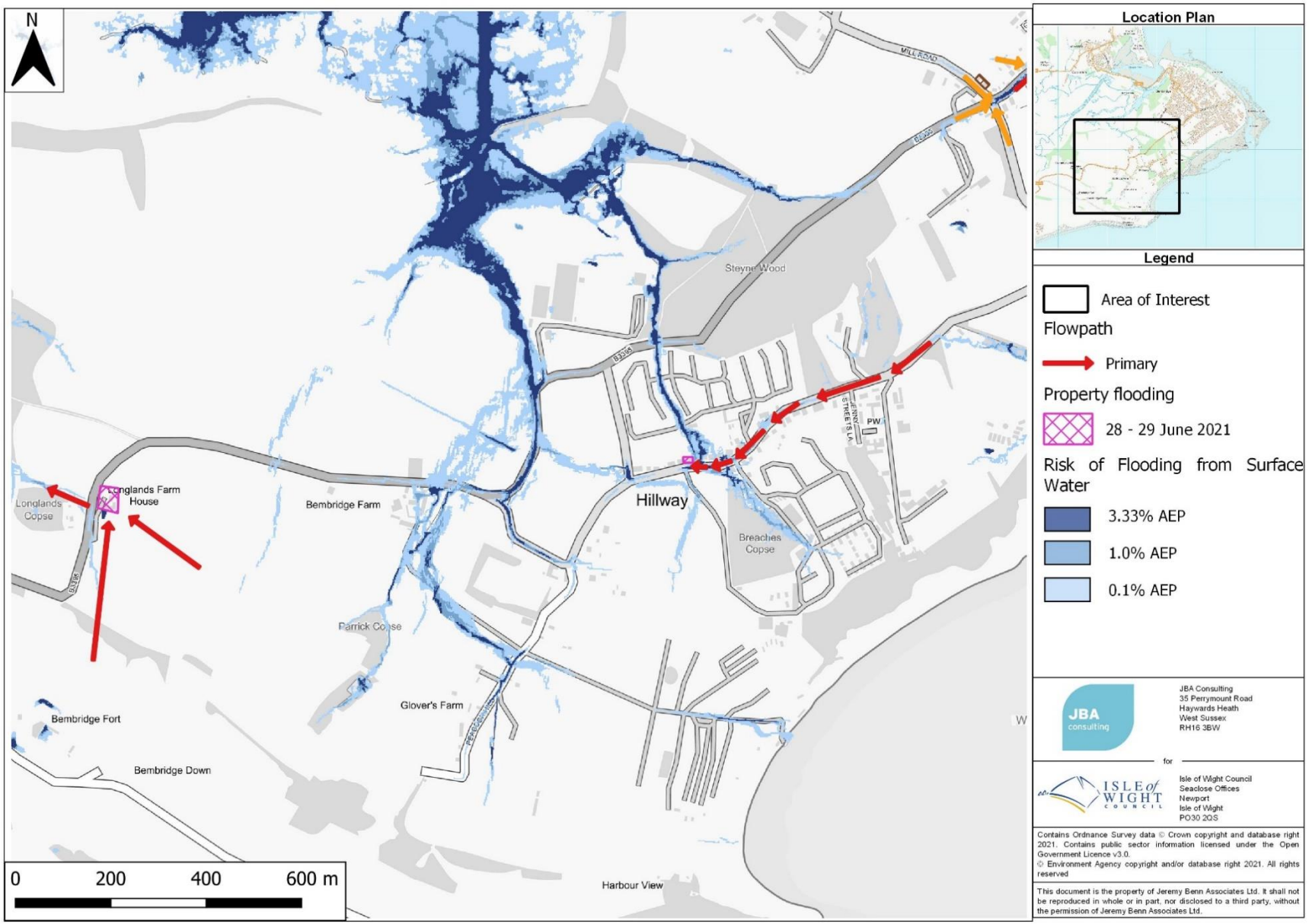

Figure 11-8: Sources, pathway and receptors - Hillway and Longlands Farm

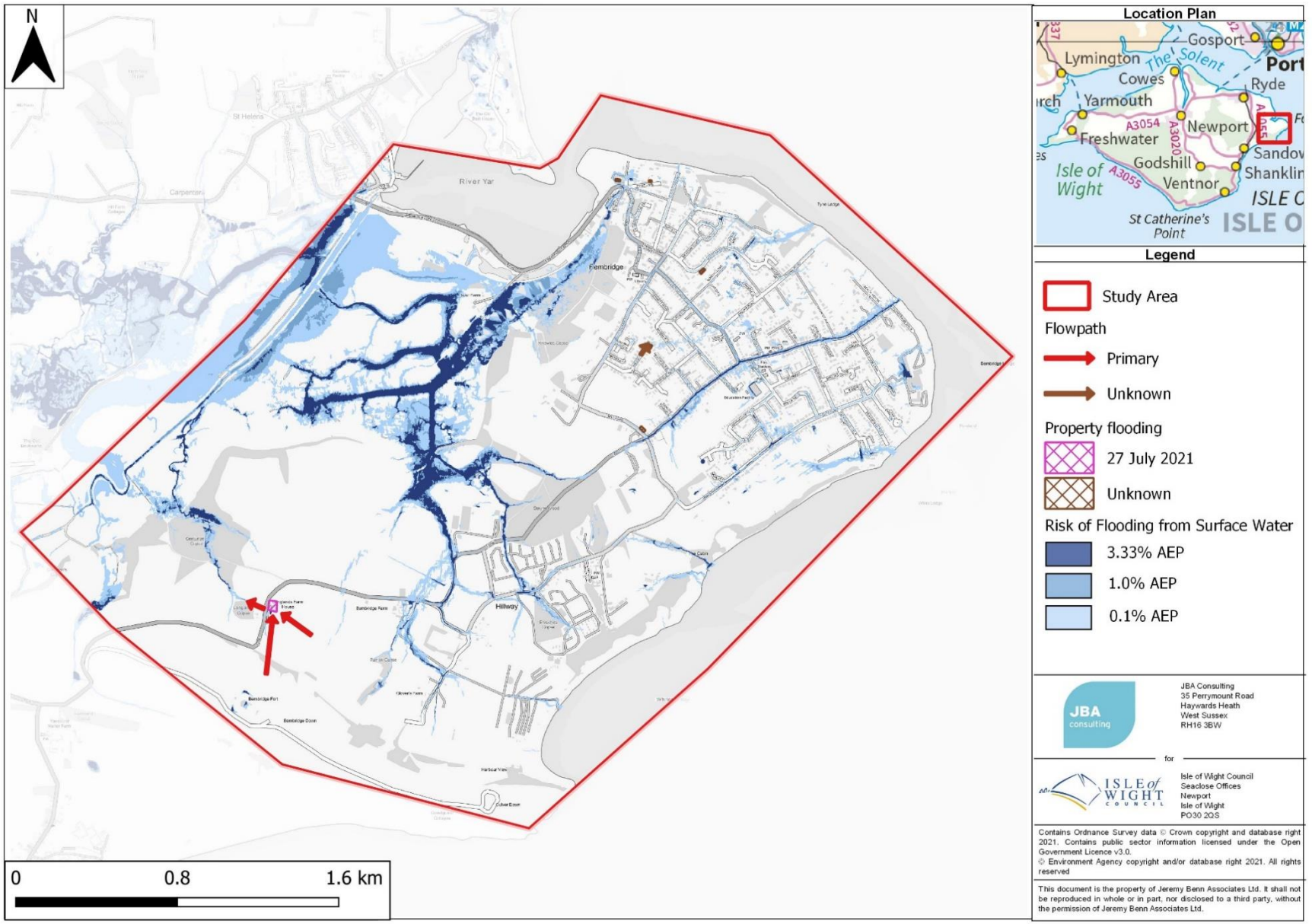

Figure 11-9: Overview of sources, pathways and receptors 27 July 2021

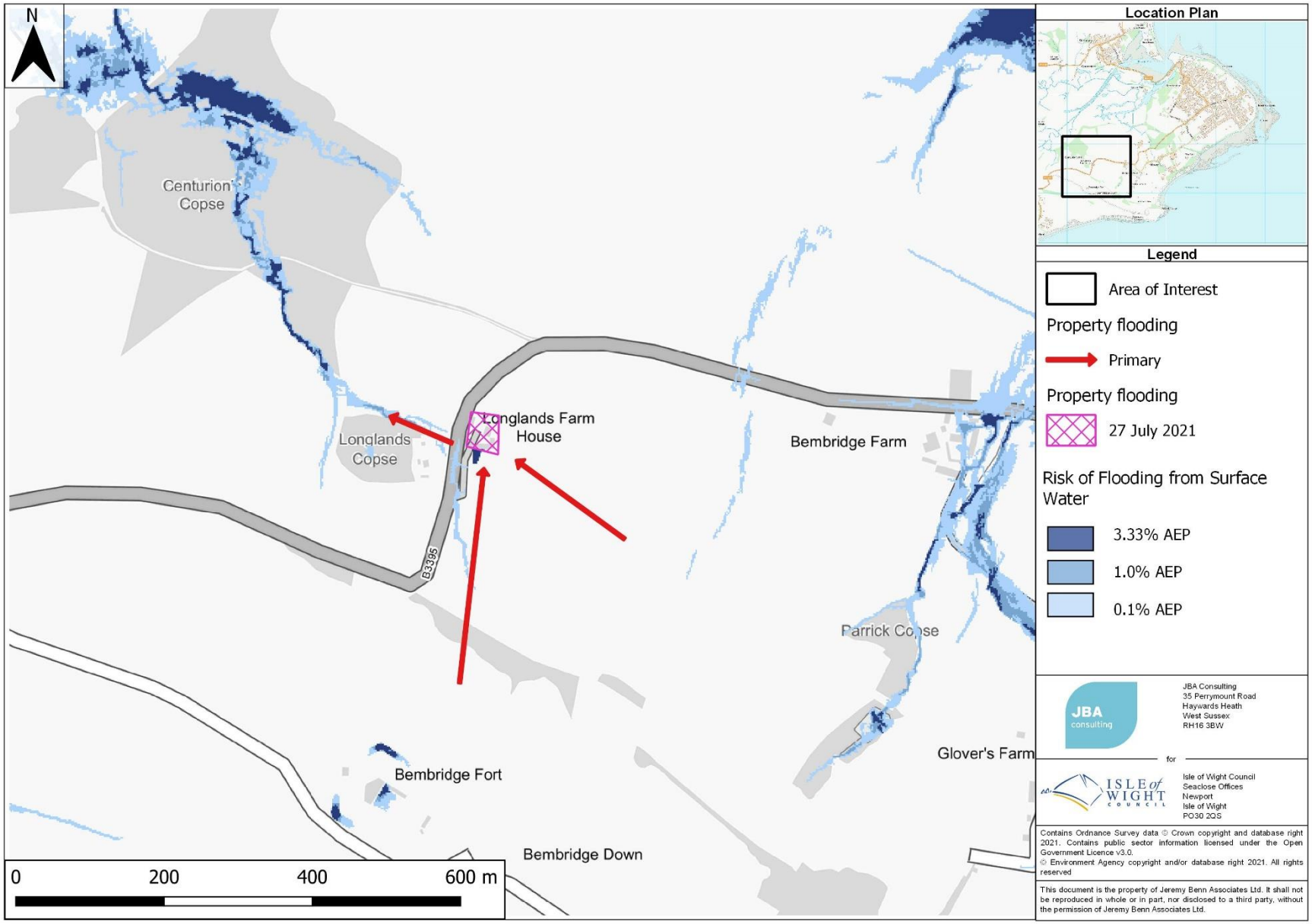

Figure 11-10: Sources, pathway and receptors for Longlands Farm on July 27, 2021

C Multi-criteria analysis methodology

As part of the Bembridge Section 19 flood investigation, a quantitative assessment was carried out on the long list options, to compare their relative benefits and limitations. The scoring was informed by site conditions, site visit observations and discussions within stakeholders.

The scores were totalled, with:

- A negative score meaning the option has high constraints or meets fewer objectives.
- A score of 0 meaning the option had a neutral impact
- A positive score meaning benefits outweigh constraints and the intervention meets more objectives. The larger the positive score, the more beneficial the scheme.

Table 11-2: Criteria used to assess long list options

Multi-criteria analysis category	Assessment criteria
Contribute towards reducing flood risk to property	Increase in flood risk to any property
	No perceived change
	Reduction in flood risk to property
Contribute toward reducing flood impacts on people/communities	Major / minor negative change in flood impacts on people/communities
	No perceived change
	Minor / medium / major positive change in flood impacts on people/communities
Contribute to improving the availability of data, evidence and modelling to support option development or flood incident response	Does not improve the availability of data, evidence and modelling
	Will provide additional data, evidence or modelling, helpful in development of interventions
	Improvement to data, evidence and modelling which is essential to the development of a capital scheme
Deliverability	Deliverability is at high risk of complexity/constraints
	Not known/not applicable
	Deliverability is at low risk of complexity/constraints
Community / resident acceptability	Community/residents are likely to have objections
	No known objections / constraints
	Community/residents are likely to be receptive and have no constraints

Multi-criteria analysis category	Assessment criteria
Contribute towards biodiversity and water quality betterment	Significant detriment
	No perceived change
	Significant betterment
Contribute towards amenity benefits	Significant detriment
	No perceived change
	Significant betterment
Contribute to carbon reduction	Significant net carbon increase
	Not known/no effect
	Significant net carbon reduction
Maintenance	High cost/frequency maintenance, requires new and specialised maintenance routines
	Not known/no effect
	No active maintenance required (passive maintenance designed)
Timescale (not included in scoring)	Long term strategic aim (>10yrs to progress, funding route unclear)
	Likely to be able to progress in next 1 – 5yrs
	Quick win (<1yr)
Cost (not included in scoring)	>£2m
	£500 - £1m
	<£100k

Table 11-3: Full multi-criteria analysis results

Isle of Wight Section 19 Investigations
Multi-Criteria Appraisal Matrix

Originated	Emma Elwood	08/03/2021
Checked	Peter Rook	08/03/2021
Approver	Fiona Hartland	09/03/2021

Evaluation Scoring: See tab 'Scoring Criteria' for details	
-2	Major negative impact.
-1	
0	Neither positive or negative impacts
1	
2	
3	
4	
5	Major positive impact

Objective	Weighting
1	1
2	1
3	1
4	1
5	1
6	1
7	1
8	1
9	1
10	0
11	0

			1	2	3	4	5	6	7	8	9	10	11	
Reference	Opportunities	Lead RMA	Flood risk benefit to property	Flood impact on people	Data and evidence	Deliverability	Community/ resident acceptability	Biodiversity and water quality betterment	Amenity benefits	Carbon reduction	Maintenance costs	Timescale (for information only)	Cost (for information only)	TOTAL
1	Do nothing	N/A	-2	-2	0	0	-2	0	0	0	2	5	5	-4
2	Business as usual (Island Roads pumping out gullies)	All	0	0	0	0	-2	0	0	0	1	5	5	-1
	Data and evidence													
3	Surface Water Management Plam	Highway Authority/ Southen Water/ LLFA	0	1	4	1	1	0	0	0	0	4	5	7
	Flood warning and incident management													
4	Local community preparation and resilience measures	Bembridge Parish Council	0	1	1	2	1	0	0	0	2	5	5	7
	Community, property and infrastructure flood resilience													
5	Reduce movement of gravel into highway drains	Highway Authority	0	1	0	-1	-1	1	0	0	2	3	5	2
6	Property flood resilience scheme	LLFA	1	3	0	2	1	0	0	0	0	5	5	7
	Maintenance and minor works													
7	Improve gullies on High Street	Highway Authority	1	1	0	0	1	0	0	0	0	4	5	3
8	Improve asset maintenance regimes	Highway Authority/ Southern Water	1	1	0	1	2	0	0	0	-1	4	4	4
9	Improve capacity of ditches on Mill Lane	Highway Authority	1	1	0	1	1	1	0	0	1	5	5	6
	Capital schemes													
10	Appraise the feasibility of providing upstream flood attenuation	Landowners in conjuction with Highway Authority/ LLFA	1	2	0	-1	2	2	2	0	-1	3	4	7
11	Increase drainage capacity in sewer network	Southern Water/ Highway Authority	1	2	0	-2	1	0	1	0	1	2	3	4
12	Extension of existing drainage at High Street/Mill Road	Highway Authority	1	2	0	0	1	0	1	0	1	2	3	6
	Planning system													
13	Introduction of a drainage and SUDs Supplementary Planning Document (SPD)	Isle of Wight Council	0	1	2	-2	1	1	1	0	0	2	5	4
14	Update to Bembridge neighbourhood plan to include drainage and surface water management policies	Parish Council	0	1	2	-2	1	1	1	0	0	2	5	4

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