Ryde Flood Investigation: Hydrological overview

Final Report

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This report describes work commissioned by the Environment Agency by an instruction dated 1st March 2024. The Client's representative for the contract was John O'Flynn of the Environment Agency. Imogen Barnsley of JBA Consulting carried out this work.

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The methodology adopted and the sources of information used by JBA in providing its services are outlined in this Report. The work described in this Report was undertaken between August and January 2024 and is based on the conditions encountered and the information available during the said period. The scope of this Report and the services are accordingly factually limited by these circumstances.

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Abbreviations

AEP	Annual Exceedance Probability
DDF	Depth Duration Frequency
EA	Environment Agency
FEH	Flood Estimation Handbook
FEH22	Flood Estimation Handbook 2022
NGR	National Grid Reference
ReFH2	Revitalised Flood Hydrograph 2

1 Introduction

1.1 Overview

Severe flooding occurred in Ryde, the Isle of Wight, on the 25th October 2023. Based on the initial Environment Agency summary report on the event[1], over 100 properties were affected by the flooding following heavy rainfall over a period of 12 hours.

In 2019, the Environment Agency completed upgrades to the existing flood alleviation scheme in Ryde, including construction of a new outfall pipe in front of the existing pumping station across Ryde sands to the marina and a flood wall which converts Simeon Street Recreation Ground to a flood storage area during high flows. According to the Environment Agency, the flood alleviation scheme was designed to better protect properties up to and including a fluvial event of a 1% Annual Exceedance Probability (AEP).

The flood alleviation scheme at the Simeon Recreation Ground consists of a 1.3m wall around the green space with three access points which can be blocked off using five or six drop boards (to match the height of the 1.3m wall). Based on the Environment Agency account of events, on the morning of the 25th October 2023, the Environment Agency duty officer instructed contractors to install two drop boards. This decision was taken to provide an initial level of storage within Simeon Recreation Ground, whilst allowing surface water to flow into the Recreation Ground. According to the Environment Agency account and images provided, surface water was accumulating around the Recreation Ground when the drop boards were implemented.

Due to the extent and severity of the flooding which occurred on the 25th of October, a flood investigation is being conducted. The investigation will be undertaken in two phases beginning with a data review (Phase 1) and detailed hydraulic modelling (Phase 2). The scope of work is detailed in Section 1.2.

1.2 Scope of works

The EA have outlined the following scope for an investigation into the flooding that occurred in Ryde on the 25 October 2023 and led to extensive internal property flooding:

The issue can be divided in to two sections: first, the nature of the storm on the 25th and the performance of the Monktonmead Flood Alleviation Scheme (MFAS) during the flood of the 25th and second, whether the Environment Agency's actions in operating the MFAS, particularly deployment of the boards or the failure to do so, caused or may have contributed to the flooding of properties in the locality.

Overall, the Environment Agency needs to understand the sufficiency of storage in the Ground with only two of the boards in place and what combination of fluvial and surface water flooded the 100 properties in the surrounding streets.

1 Ryde, IOW Flooding Review October 2023, 10 November 2023.

Dealing with the first:

a) confirm what rainfall fell across the Monktonmead Brook catchment and determine rainfall return period (i.e. all day of 25th).

b) What were the fluvial flows in the Monktonmead Brook?

c) What were the surface water flows into the Ground and into the nearby flooded streets; The Strand, Simeon Street, Cornwall Street and West Hill Road?

d) Confirm whether the MFAS performed as designed, bearing in mind the EA procedures for its operation and the nature of the storm?

e) Did the event exceed the MFAS design parameters, by which we mean what standard of protection MFAS provides (see enclosures 5, page 60)?

Dealing with the second:

f) Did the Environment Agency comply with its procedures and if it did not, was the departure from the procedures reasonable?

g) Was the flooding of nearby houses exacerbated by the fact that only 2 boards were fixed at each Opening?

To answer questions f) and g), you may need to consider the following:

Did surface water flow into the Ground over the two installed flood drop boards and how much?

If not, when did fluvial water start flowing out over the two installed flood drop boards and how much?

Did surface water flood properties (and which ones) before they were flooded by fluvial flows?

How much depth (and extent) of flooding was caused by fluvial flows above that caused from surface water flows?

Would the recreation ground have held all of the fluvial flows, or would it have overtopped with all the flood drop boards in place?

If it would have overtopped if the flood wall around the Ground, what would the impacts have been in terms of flood depth, timings, extent and properties flooded?

The work as part of this scope will be undertaken in two phases. Phase 1 includes a data review and method statements. Phase 2 includes surface water and hydraulic modelling and hydrological calculations.

This report focuses on reviewing the available data and answering Question a) as part of Phase 1. A detailed hydrological data review of the event on the 25th of October 2023 is provided, as well as an estimate of the rainfall return period of the event. Other hydrometric data is reviewed and used to gain an understanding of the processes of flooding on the 25th October.

1.3 Catchment overview

A detailed analysis of catchment properties can be found in the Flood Estimation Handbook calculation record associated with this Flood Investigation[2]. A short summary of key catchment properties is provided here. For a more detailed assessment of catchment properties, please refer to the associated Flood Estimation Handbook calculation record.

The Monktonmead Brook flows through Ryde in the north east of the Isle of Wight. The Monktonmead brook catchment is small at approximately 11km2, with the southern section of the catchment being dominated by rural arable land and the northern third of the catchment being dominated by the town of Ryde. From Simeon Street, the Monktonmead Brook flows through a culvert before emerging via a tidal outfall which includes a tidal flap. Flows through the culvert are pumped to maintain flows out of the catchment during high tide. Monktonmead Flood Alleviation Scheme is designed for Monktonmead Brook to overtop into the Simeon Street Recreation Ground. A low wall around the recreation ground and on Esplanade is designed to constrain fluvial flood water within the recreation ground during high flows.

A site visit to further understand the catchment hydrological function will be conducted as part of Phase 2 of this project.

2 Ryde Flood Investigation: FEH Calculation Record

2 October 2023 event assessment

2.1 Data available in Monktonmead Brook

Hydrometric data relating to river levels and cumulative rainfall will be used to assess the hydrological timeline of events in Ryde on the 25th October 2023. Figure 2-1 and Table 2-1 show locations and details of hydrometric gauges which recorded data during the October event. Rainfall, stage, flow, and tidal level data will be visualised to understand the hydrological processes which led to flooding in Ryde during the October 2023 event.

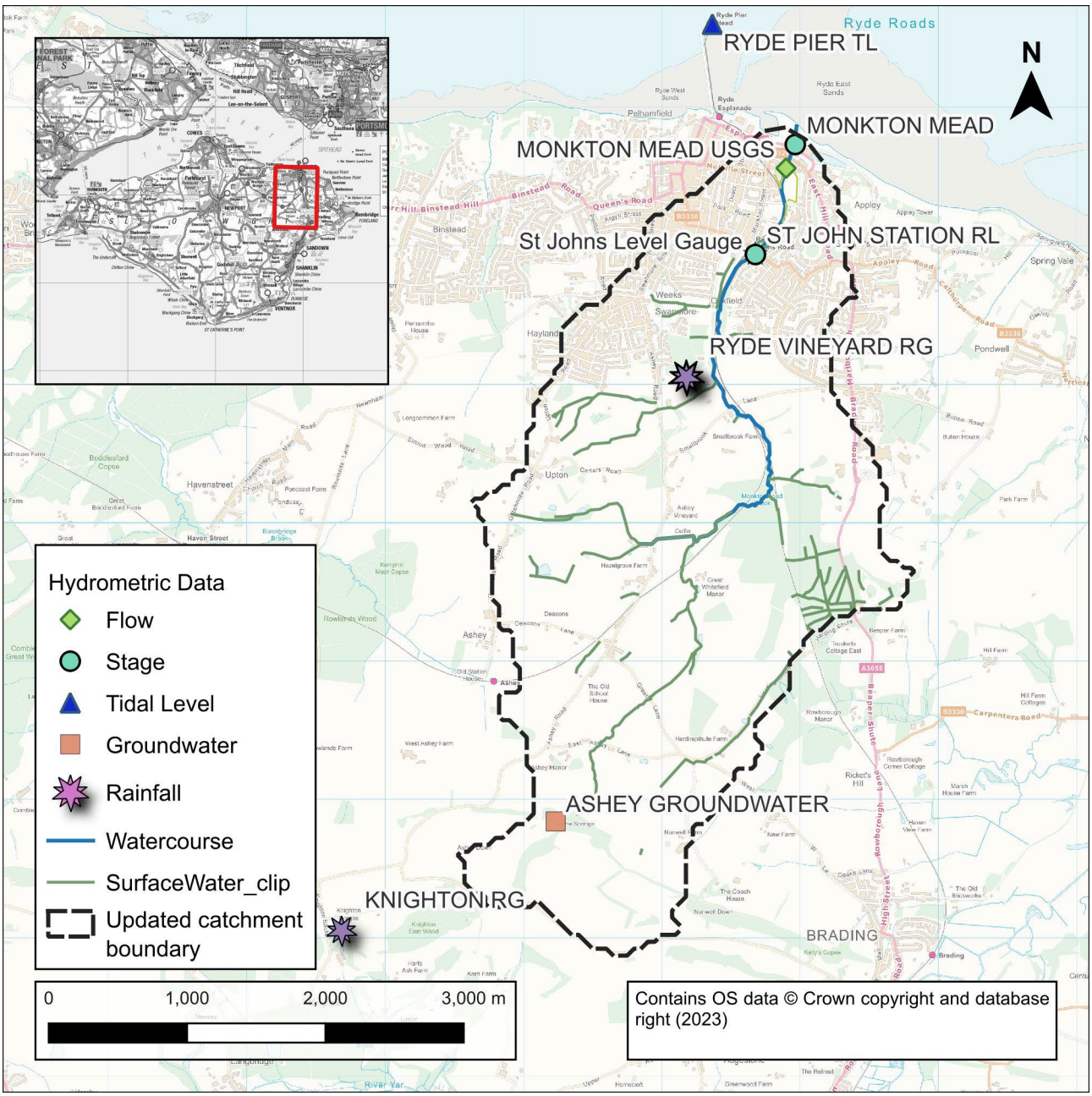


Figure 2-1 Hydrometric data available for the October 2023 event in Ryde

Table 2-1 Details of Ryde hydrometric data, October 2023

Station Name	Type	Resolution	Period of record
Ryde Vineyard Rain Gauge	Rain gauge	15-minute	May 2005 - March 2024
St Johns Station River Level	River level	15-minute	January 2004 - March 2024
Monktonmead Ultra Sonic Gauging Station	Flow and river level	15-minte	May 2013 - March 2024
Monktonmead	River level	15-minute	January 2013 - March 2024
Ryde Pier Tidal Level	Tidal level	15-minute	January 2004 - March 2024
Ashey Groundwater	Groundwater borehole	Sub-daily	July 2023 - June 2024
Alverstone Groundwater	Groundwater borehole	Sub-daily	April 2011 - present

It should be noted that other sources of hydrometric data for the Monktonmead Brook catchment are available. Table 2-1 only refers to sources of hydrometric data which were recording during the 25th October 2023 event, Further details on these gauges and other relevant gauges which were identified can be found in the Flood Estimation Handbook calculation record which is associated with this report[2].

Catchment-averaged rainfall is the total rainfall which fell on the land surface of the catchment. Rain gauges measure the cumulative rainfall in a single static location. To calculate catchment-averaged rainfall using gauged rain data, data from multiple gauges within and surrounding the catchment in question are used to gain an average across space. There are many rainfall gauges on the Isle of Wight, but they are slightly limited in data availability for the 25th October 2023 event (Figure 2-2). Catchment-averaged rainfall can be calculated using the Knighton and Ryde Vineyard rainfall gauges.

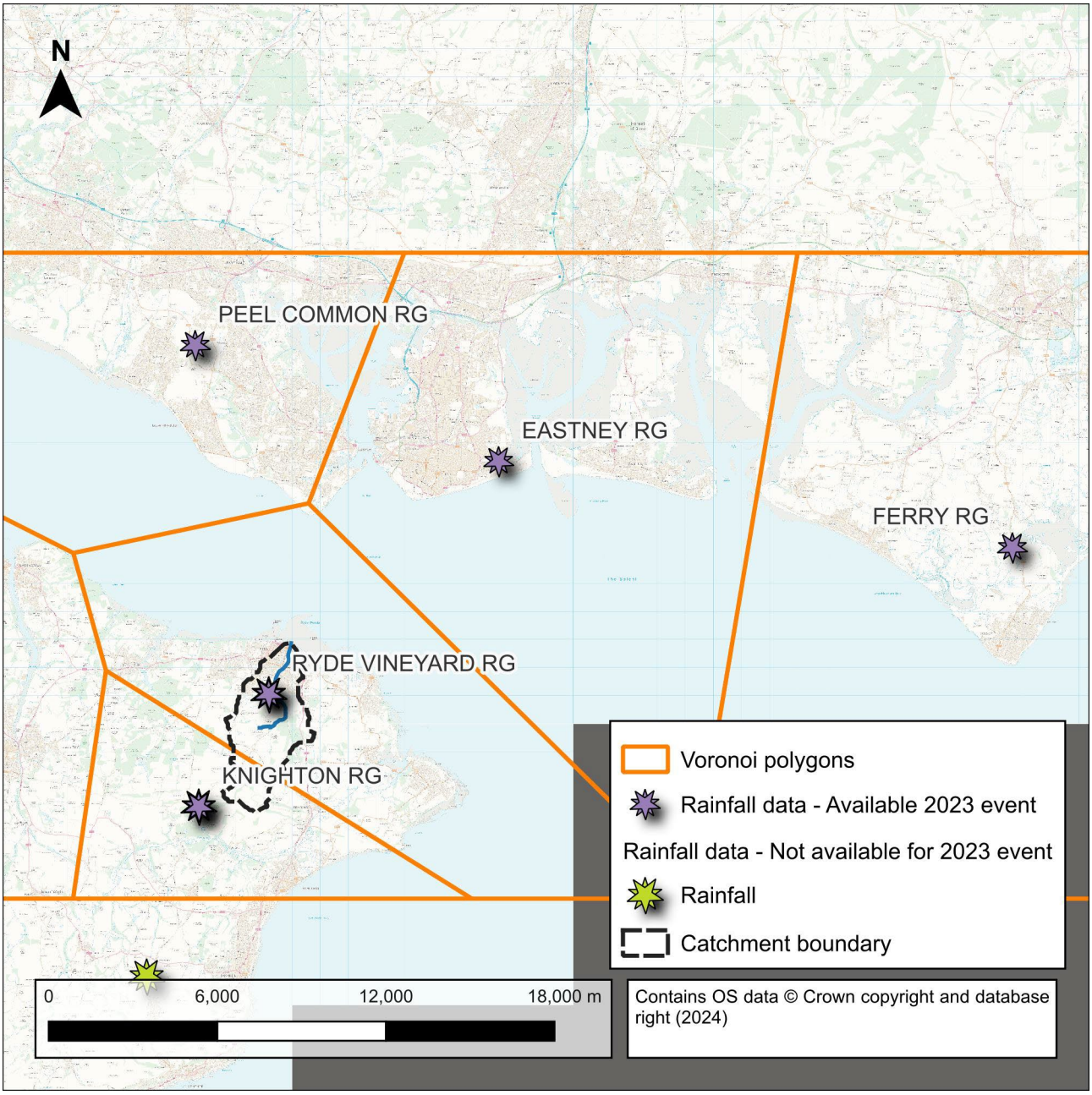


Figure 2-2 Spatial density of rainfall gauges and coverage of the Monktonmead Brook catchment

For this study HYRAD rainfall radar data for the 25th October 2023 and the three preceding months has been obtained. The HYRAD rainfall radar dataset is the standard radar system used for flood warning and rainfall estimation across England, Wales, Scotland, Northern Ireland and Belgium. It is considered the most accurate system because it generates estimates by merging radar and rain gauge data to construct rainfall time series and forecasts. The HYRAD rainfall radar pixels extracted across the Monktonmead Brook catchment to calculate catchment-averaged rainfall are shown in Figure 2-3 below.

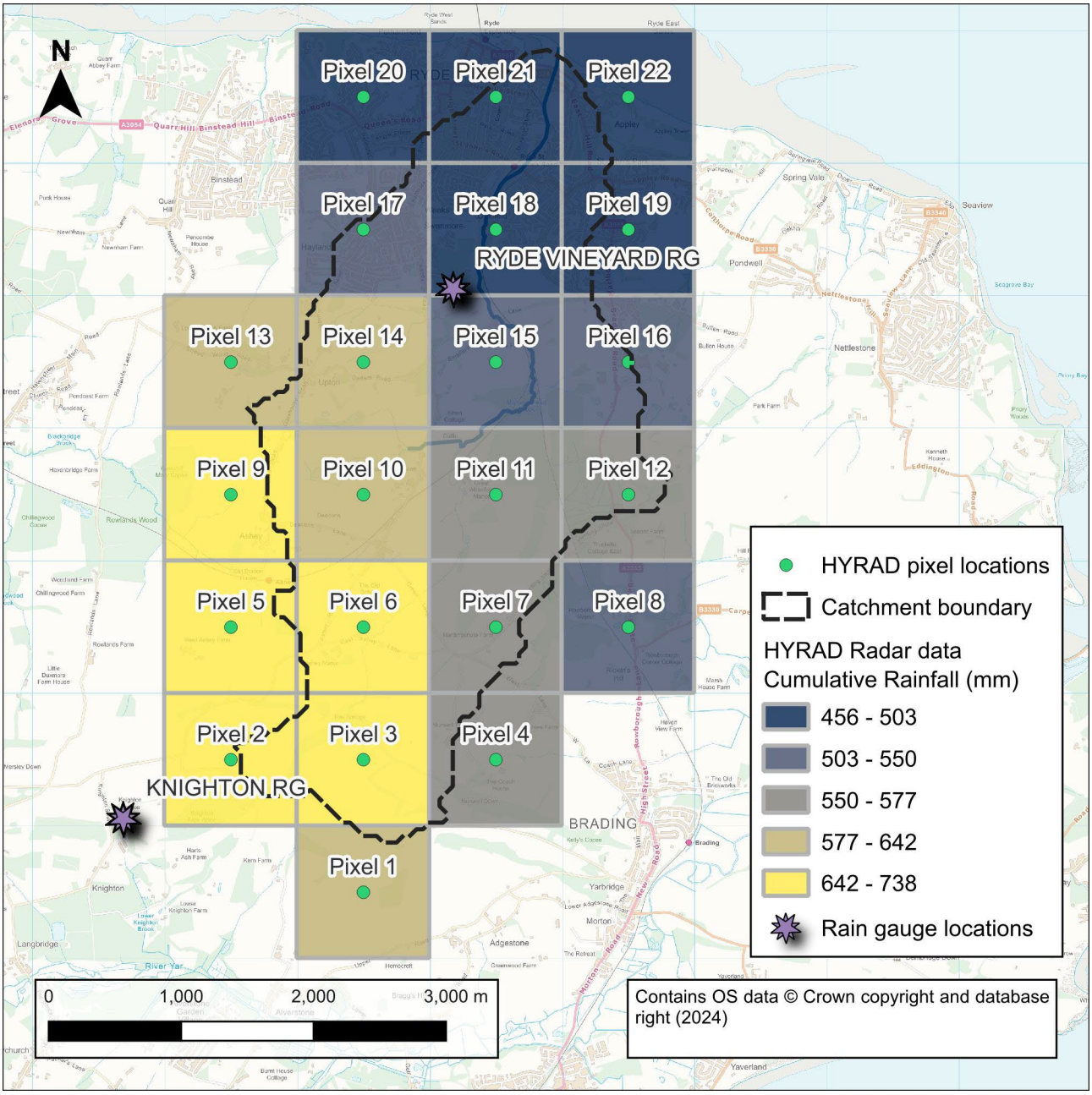


Figure 2-3 HYRAD rainfall radar pixels used to calculate catchment-averaged rainfall and cumulative rainfall per pixel

To understand how gauged rainfall and HYRAD radar rainfall datasets differ, readings from HYRAD Pixel 18 and the Ryde Vineyard rain gauge were compared on the 25th October 2023 (Figure 2-4). As can be seen in Figure 2-4, the HYRAD radar rainfall dataset underestimates rainfall compared to the Ryde Vineyard rain gauge for many timesteps. It is clear from Table 2-2 when comparing the two rain gauges and from Figure 2-3 that rainfall intensity varies spatially, with more intense rainfall recorded in the south east of the Monktonmead Brook catchment than in the north. Figure 2-4 shows that the HYRAD radar dataset measures greater rainfall peaks. However, greater cumulative rainfall estimates are

recorded at both rain gauges when compared to their closest HYRAD pixels over the course of the 12-hour event

Table 2-2 Cumulative rainfall totals HYRAD pixel 18 and Ryde Vineyard RG

	Pixel 14	Pixel 15	Pixel 17	Pixel 18	Pixel 2	Catchment averaged
HYRAD Total Rainfall (mm)	87.15	77.19	82.21	71.26	88.08	72.6
Rain Gauge	**Ryde Vineyard**	**Knighton rain gauge**	**-**	**-**	**-**	**Combined (Ryde 80% and Knighton 20%)**
	80.96	92.77				83.32

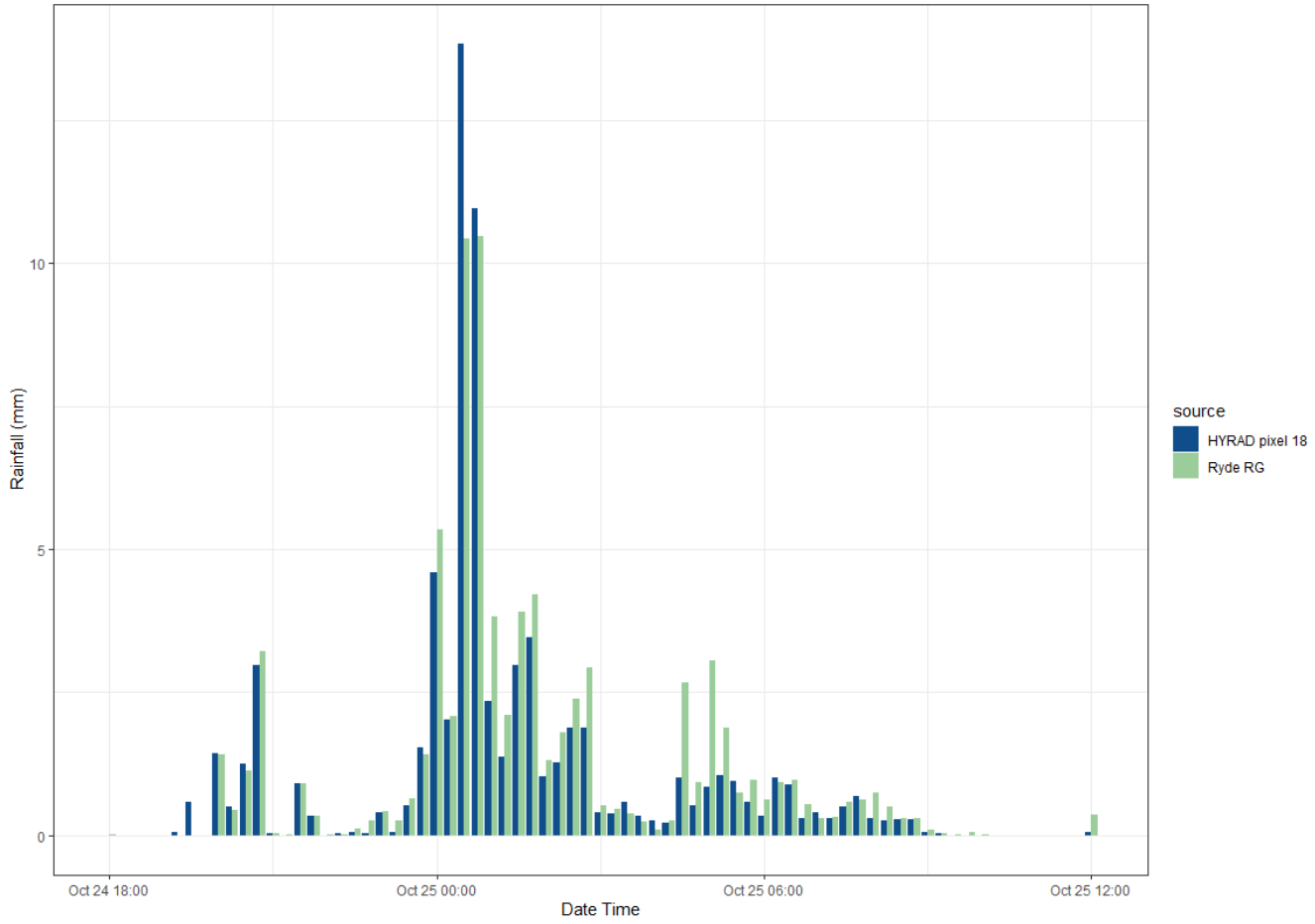


Figure 2-4 Comparison of recorded rainfall from HYRAD radar Pixel 18 and Ryde Vineyard rain gauge during the October 2023 event

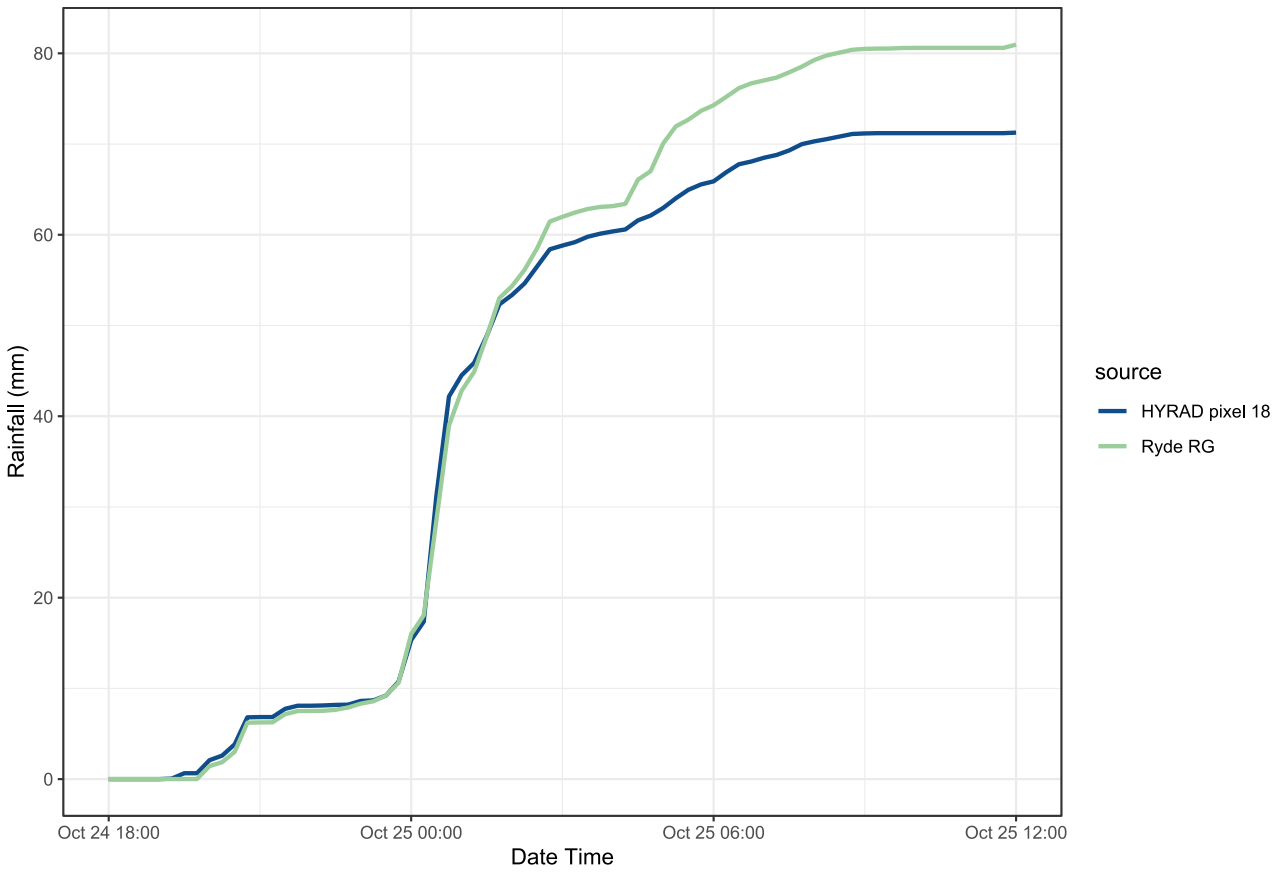


Figure 2-5 Comparison of cumulative recorded rainfall from HYRAD radar Pixel 18 and Ryde Vineyard rain gauge during the October 2023 event

2.2 Antecedent conditions

Antecedent conditions describe the climate conditions preceding an event. The amount and intensity of rainfall, as well as meteorological conditions and agricultural practices, in the months before an event set up the conditions of the land surface on which the rain falls. This includes the saturation the soils which in turn dictates the rate of infiltration or the amount of surface runoff generated. Saturated soils (caused by heavy rainfall in the month prior to the event) have fewer pore spaces between soil particles, meaning that a higher proportion of rainfall becomes runoff which flows quickly over the land surface. Other conditions which can lead to a higher proportion of overland flow generation can be the presence of impermeable land surfaces in urban areas (this is the case in the town of Ryde). Furthermore, under intense rainfall, the rate of water input on the land surface can be greater than the rate at which the soil can absorb it caused infiltration excess overland flow. This can be exacerbated by soil compaction due to land management or soil baking following droughts. This can cause a 'flashy' flood response, where peak flow or water levels occur very quickly over a short period of time.

Wet antecedent conditions can also cause high river flows in the river channels before the event. This means that river channels have reduced capacity for additional water during the event, increasing the potential for channel capacity to be exceeded, causing bank

overtopping and fluvial flooding. Due to the chalk headwaters of the Monktonmead Brook catchment, wet antecedent conditions can raise the groundwater level and increase baseflow inputs to the watercourse, raising water levels.

Therefore, antecedent conditions can influence the severity of an event based on the soil saturation and river levels at the time of rainfall. Because of this, the conditions prior to the event on the 25th October 2023 are examined to understand how they may have affected the outcomes of river levels and surface runoff.

2.2.1 Antecedent rainfall

Radar rainfall data was available from July to November 2023 as part of this project and has been plotted in Figure 2-6. This shows that rainfall throughout the end of October and November was far more regular and intense than through the preceding months. However, there was a large rainfall peak in August.

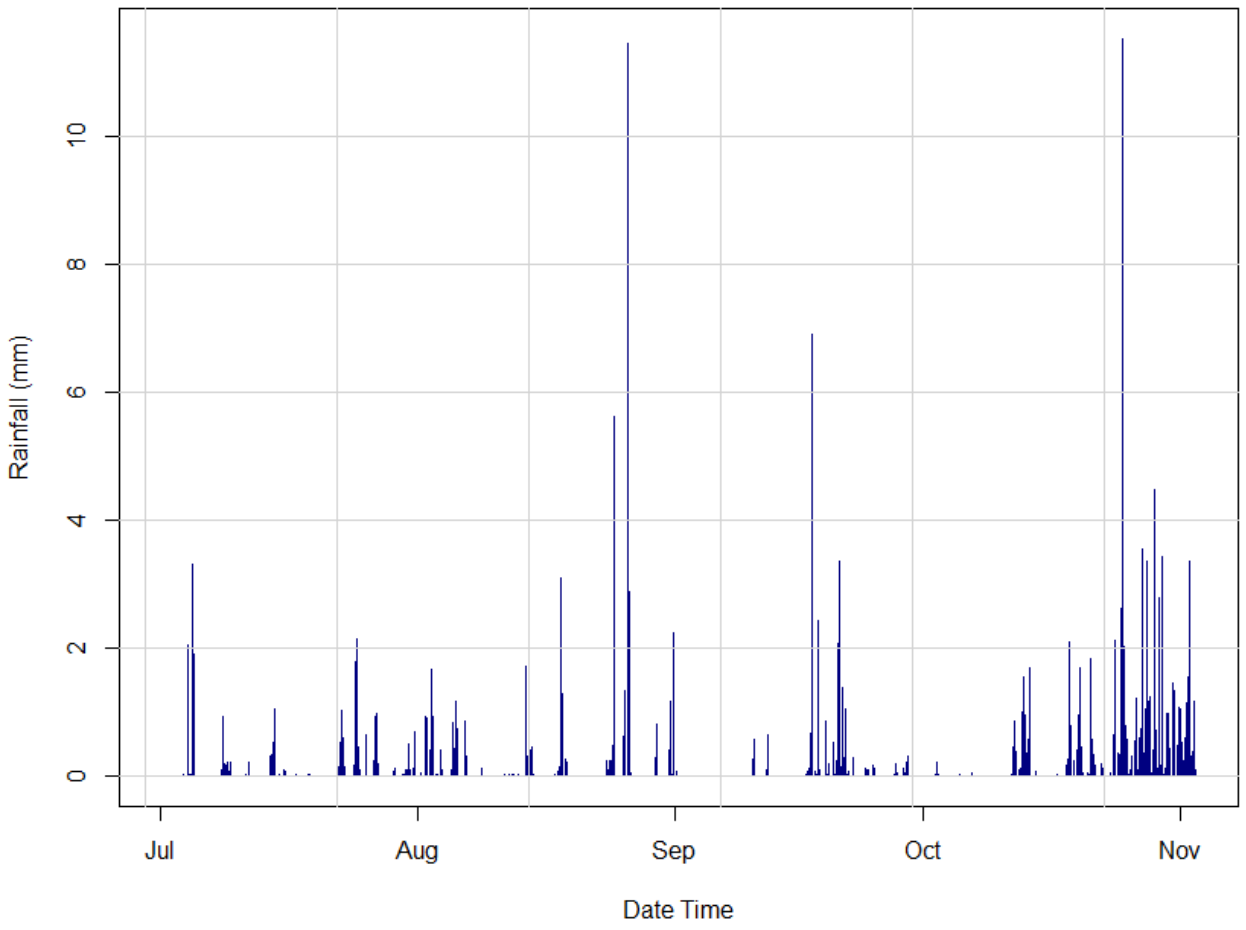


Figure 2-6 Antecedent rainfall in the Ryde catchment between July and November 2023

Gauged rainfall data at the Ryde Vineyard Gauge is available for 19 years (2005 to 2024). This dataset has therefore been used to compare the annual average total monthly rainfall against the monthly totals throughout 2023 to put the antecedent rainfall for the October event into context.

This analysis shows that rainfall preceding the October 2023 event was generally wetter than average. The preceding July, August and September were 58%, 57%, and 8% greater than the average monthly totals from the Ryde Vineyard rain gauge record (Table 2-3). This occurred after a very wet spring period, especially over the month of March. Over the period of 2023, there were only two months with rainfall below the monthly average total rainfall (February and June), indicating that the year up to October had been wetter than average.

Table 2-3 Comparison of average monthly totals and 2023 monthly totals at the Ryde rain gauge

Month	Average monthly total	2023 monthly total	Percentage difference
January	85.3	112.1	31.4
February	64.4	7	-89.1
March	49.7	100.1	101.3
April	42.4	77.7	83
May	41.4	47.6	14.9
June	46.9	23.1	-50.7
July	50.9	80.4	58.1
August	58.3	91.7	57.2
September	54	58.2	7.7
October	104.2	256.1	145.8
November	99.6	134.5	34.9
December	97.3	141.1	45

2.2.2 Antecedent groundwater levels

Groundwater levels were measured based on borehole records. Two boreholes were considered as part of this analysis, the Ashey Borehole which is located within the Monktonmead Brook catchment approximately 4.2km from Ryde (SZ 58240 87848) but has a short record, and the Alverstone Borehole (NGR: SZ5744385007) which is located approximately 7.2km from Ryde. The Ashey gauge did not become operational until July 2023. Because this is the closest data, it will be used to understand local and short term trends in groundwater levels at the time of the October 2023 event. The Alverstone borehole data will be used to understand how the groundwater conditions during the October 2023 event compare to long term trends.

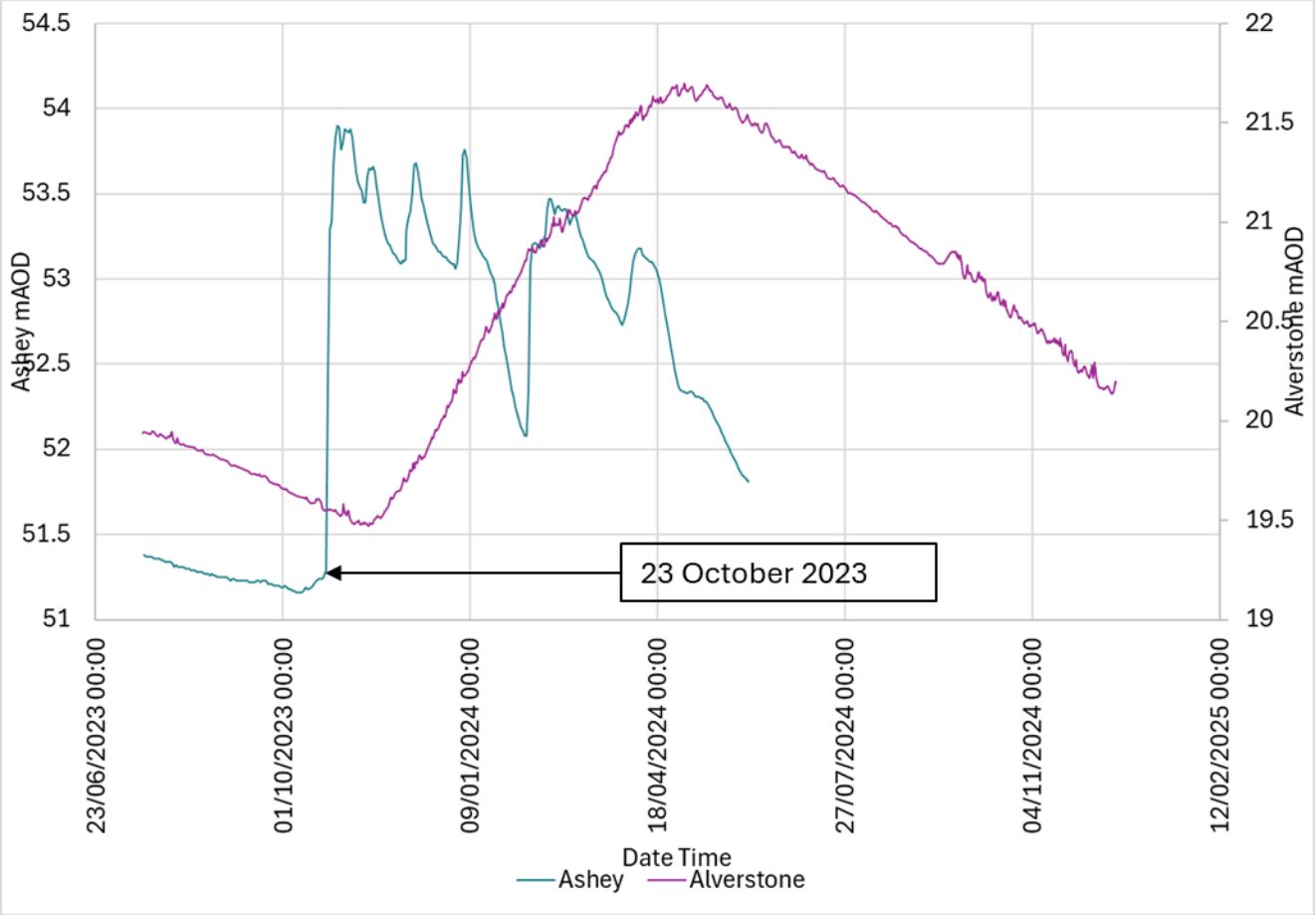


Figure 2-7 comparison of Ashey and Alverstone boreholes before and during the October 2023 event

Figure 2-7 is a comparison of the groundwater levels at the Ashet and Alverstone gauges between July 2023 and present day. As can be seen, the Ashey gauge is far more sensitive to rainfall and groundwater levels vary over shorter periods of time. From July to early October 2023, groundwater levels at both boreholes were in decline. At the Ashey gauge, during the October 2023 event, groundwater levels rose by 2.6m between the 23rd and 31st October, demonstrating a rapid rate of recharge due to the heavy rainfall. In contrast, the Alverstone borehole shows a small peak in groundwater level, but the trend towards aquifer recharge does not occur until late November in 2023. This shows that groundwater levels were generally in recession before the event. As evidenced by the Ashey borehole data, it is likely that the Monktonmead Brook catchment is capable of rapid recharge in response to rainfall.

The Alverstone borehole was used to compare groundwater levels across years (Figure 2-8) to compare October 2023 groundwater levels to the long-term average for October throughout the period of record. This analysis shows that October groundwater levels were approximately 0.33m higher at the Alverstone gauge in October 2023 than the average October levels across the period of record (March 2011 to present). Therefore, groundwater levels at the time of the October 2023 event were slightly above average. Figure 2-8 shows

that groundwater levels are the Alverstone borehole were consistently higher than the long-term average throughout 2023.

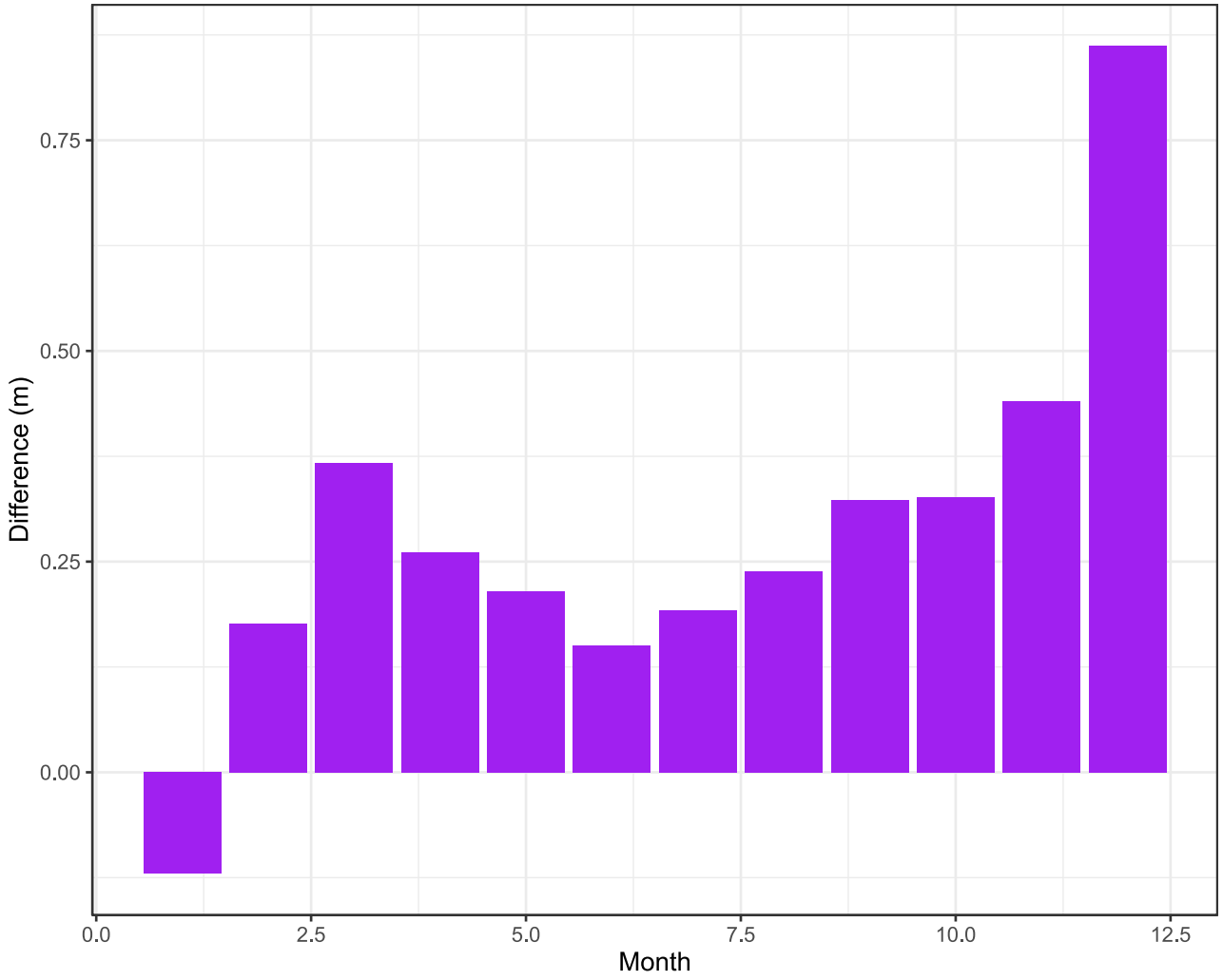


Figure 2-8 Difference of 2023 groundwater levels at Alverstone borehole compared to the average in the record

The effect that slightly raised groundwater levels may have had on water levels at the St Johns River level gauge in October 2023 were also analysed. It was found that October water levels in 2023 prior to the event on the 25th were the same as average October water levels for the period of record (February 2004 to present day). Therefore, despite slightly higher than average groundwater levels, water levels were not raised at the time of the 25th October 2023 event when compared to the long-term average.

2.2.3 Antecedent soil moisture

The October 2023 Monthly Water Situation report[3] published by the Environment Agency was used to understand regional trends in antecedent soil moisture at the time of the event. Soil Moisture Deficit is the amount of water needed to refill the soil to its full capacity, which is the maximum amount of water the soil can hold without leaking or pooling water. The lower the soil moisture deficit, the wetter the soils and the more surface runoff is generated by the soils. It should be noted that a soil moisture deficit value of 0 does not always mean total saturation.

The Water Situation Report indicates that soils moisture deficit values were slightly below the long-term average across England as soils became wetter in many areas due to above average rainfall. This effect was particularly pronounced in the Southeast of England.

Whilst the soil moisture deficit was slightly below the long-term average, the regional soil moisture deficit by the end of September 2023 was 71mm-100mm indicating that there was capacity within the soil at the beginning of October. By the end of October, this had dropped to 11-40mm, showing that the soils have become significantly wetter on the Isle of Wight throughout October due to rainfall, but were still far from having reached full saturation capacity.

2.2.4 Antecedent conditions summary

Rainfall in the months preceding October 2023 was slightly above the long term average. October 2023 was extremely heavy and higher than the long term average. Groundwater levels were also found the be slightly higher than average in October, this did not affect the water levels. Additionally, soil moisture was higher than the long term average, but soils were not saturated at the time of the October 2023 event. Therefore, antecedent conditions were slightly wetter than average conditions but were not totally saturated. Whilst wetter than average antecedent conditions may have contributed marginally to flooding in the 25th October 2023, the extremity of the flooding which occurred is most likely due to the intensity of the rainfall which occurred during the event.

2.3 Tidal influence

The outlet of Monktonmead Brook in Ryde is managed by a tidal outfall with a flap that closes during high tides to prevent backflow. During high tides, two pumps move water through a culvert to maintain outflows. The tidal flap is located directly downstream of the pumps. Consequently, the outflows from Ryde depend on tides and the pumps. If water flow exceeds the pumps' capacity, it can cause flooding. At low tide, water flows out by gravity.

3 Monthly Water Situation Report: England, October 2023, Environment Agency. https://assets.publishing.service.gov.uk/media/654e4a286a650f000dbf4810/Water_situation_report_for_England_October_2023.pdf

Understanding tide levels during the October 2023 event is crucial to assess their impact on water flow out of the catchment and into the sea. Storms can cause tidal surges and extreme wave heights which could cause the tidal flap to close and the pumps to be activated outside of normal high tide.

Wave height data from the closest available wave height buoy (Hayling Island) has been used. The maximum wave height on the 25th of October was 1.85m. The storm threshold in this location is 2.77m. The wave heights were not high enough to be classified as a storm during the event. Further understanding of how this may have influenced the tidal flap closure is required.

Tidal data from the closest tidal gauge at Sandown Pier was also used to understand the level of storm surge at the time of the event. The storm surge on the 25th October 2023 was 0.432m, with the level of significance being 0.76m. Furthermore, the rainfall peak occurred approximately mid-tide.

As a result, in terms of wave height and storm surge, the October 2023 event was not classified as a tidal storm.

2.4 Rainfall return period estimation

An understanding of the return period of the Ryde event on the 25th October 2023 is important to put the it into context. One of the key drivers of both fluvial and surface water flooding is rainfall. Therefore, the event rarity will be calculated based on the total rainfall depth during the event.

Catchment-averaged rainfall can be extracted directly from the HYRAD tool based on the rainfall radar data. Average rainfall across the Monktonmead Brook catchment between the 12:00 on the 24/10/2023 to 00:00 on the 26/10/2023 has been plotted to capture the full event rainfall (Figure 2-9).

The maximum recorded rainfall was 11.52mm within a 15-minute period (recorded at 00:30 25/10.2023). The full rainfall event occurred over a period of twelve hours (21:30 24/10/2023 to 09:30 25/10/2023), with a total of 72.6mm of rainfall over this period. However, the majority of the rainfall fell within a period of six hours between 21:30 24/10/2023 and 02:30 25/10/2023. 52.5mm of the total 72.6mm fell within this six-hour period. Therefore, the intensity of the rainfall during this six-hour period was high.

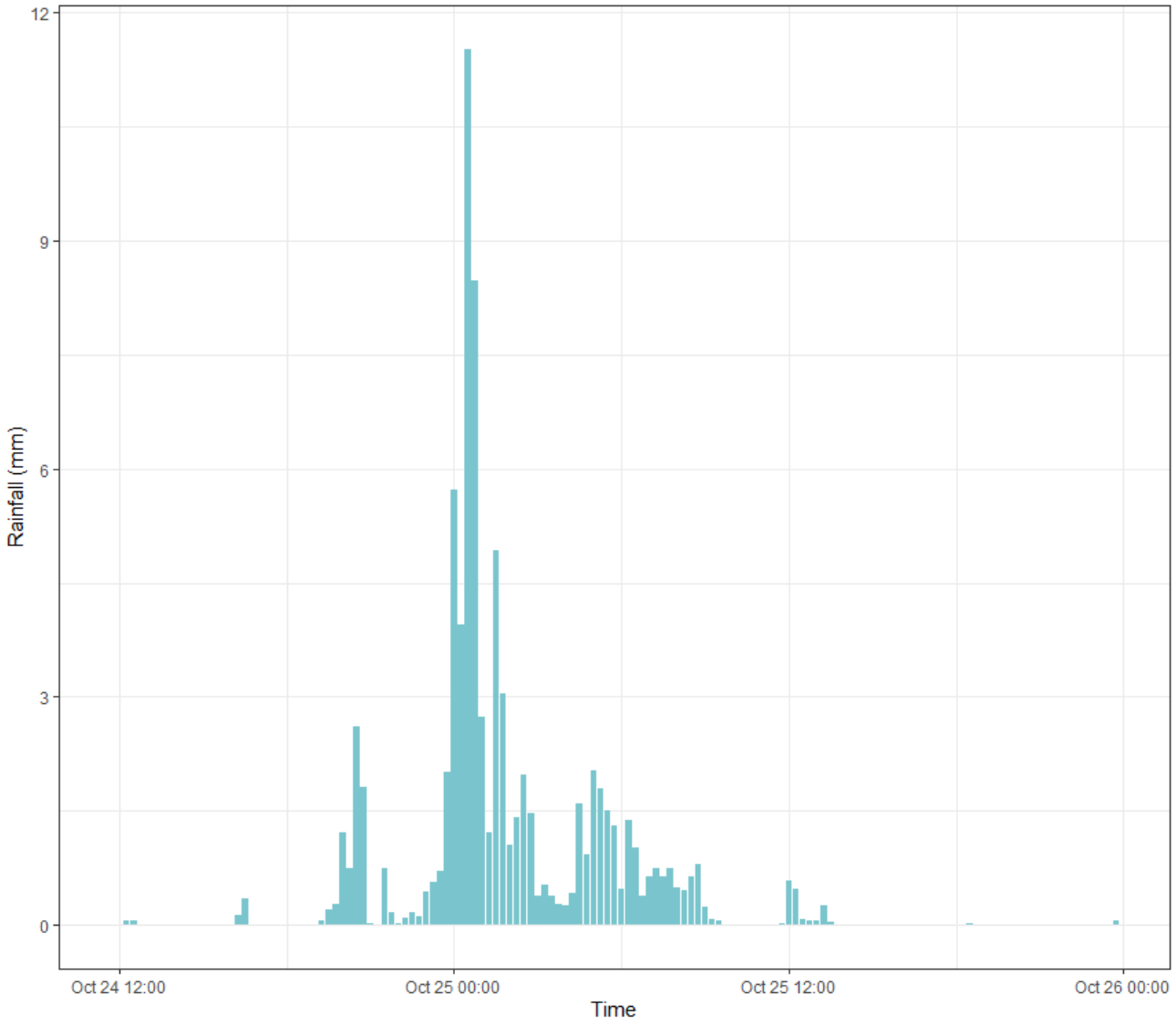


Figure 2-9 Catchment-average rainfall for Ryde during the 25th October 2023 event

An event return period has been estimated using the Flood Estimation Handbook 2022 (FEH22) depth-duration-frequency (DDF) model. This model derived the statistical relationship between the depth, duration, and frequency of rainfall based on recorded annual maximum rainfall. This model allows the return period of an event to be calculated based on the depth and duration of rainfall in a specific location. The FEH22 model is available on the FEH Web Service[4].

Calculating rainfall return periods can be highly uncertain. This is partially due to the range in measured rainfall for the Monktonmead Brook catchment. For example, the catchment averaged HYRAD radar total rainfall over the 12-hour event was 72.6mm, which is estimated to be approximately a 1.25% Annual Exceedance Probability (AEP) event (80-year return period). Whereas the gauged catchment averaged rainfall from the Ryde Vineyard and Knighton gauges results in a total rainfall of 83.32mm which is estimated to

4 FEH Web Service. https://fehweb.ceh.ac.uk/Map

be approximately 0.5% AEP (200-year return period). The event duration was also compared to the critical storm duration of the catchment. According to the ReFH2 software, using catchment descriptors, the critical storm duration of the Monktonmead Brook catchment is 7.5 hours. The maximum rainfall depth over this period was calculated as 64.5mm for the catchment-averaged HYRAD data, or 70.8 for catchment-averaged rainfall data. This is equivalent to a 1.25% and 0.68% AEP respectively (equivalent to 80-year and 148-year return periods). Therefore, due to the uncertainty in estimating rainfall event rarity and return periods, a range has been provided. The estimated AEP for the October 2023 event is between a 1.25% AEP event and 0.5% AEP event (equivalent to 80-year and 200-year return periods). This demonstrates that the rainfall during the event was intense and rare. The Ryde Flood Alleviation scheme, as reported by the Environment Agency, provides a Standard of Protection of a 1% AEP event (1 in 100-year return period event). However, the Standard of Protection threshold was calculated based on a fluvial return period.

Because the pump and action of the tidal flap modify flows and water level in the Monktonmead Brook, an estimate of fluvial flow return period is not thought appropriate without the use of the model (to represent interactions between these mechanisms). Therefore, as part of Phase 1, a fluvial return period has not been estimated. This will be estimated as part of Phase 2 to contextualise the performance of the Flood Alleviation Scheme during the event.

2.5 Event overview

Catchment-averaged radar Rainfall, all available river level data, and local tidal level data during the 25th October 2023 flood event in Ryde has been plotted in Figure 2-10. This will be used to understand the hydrological response of Monktonmead Brook through Ryde during the event. The locations of the respective gauges plotted in Figure 2-10 can be found in Figure 2-1 for reference.

One of the key observations from Figure 2-10 is the extent of tidal influence on river levels. The Monktonmead Level gauge is the gauge furthest downstream and is clearly influenced by tides because water levels rise and fall in conjunction with the Ryde Tide Level. On the 25th October 2023 event, the peak water level occurred in conjunction with the peak tide level.

The USGS (Ultrasonic Gauging Station) Monktonmead Level data is located directly upstream of the Monktonmead culvert and records levels and flows at the culvert inlet. The level and flow monitored in this location is heavily influenced by the pump operation. The jagged oscillation in the water levels and flows measured in this location are caused by the pumps being turned on and off. There are two pumps in the culvert which are automatically activated when the water level reaches specified thresholds. As can be seen in the high tide before the event (between Oct 24 12:00 and Oct 25 00:00), the first pump turns on and off approximately every hour, allowing water levels to rise and fall three times during a high tide. During the event on the 25th October, the first pump switched on at approximately 02:30, preventing water levels in this location exceeding 7.5m. The second pump switched on at approximately 06:00, shown by the significant drop in water level to approximately

5m. This also coincided with high tide. The second pump switched off at approximately 10:30, allowing water levels to raise to approximately 7.5m. At this stage in the event, water levels were receding, and the tide was also falling. As a result, water levels at the USGS Monktonmead level gauge began falling. The dual pump system and reaching level thresholds causes the overall u-shape of the river levels during the 25th October 2023 event. Therefore, the lower Monktonmead Brook is significantly influenced by the tide and the pumping regime.

The data recorded at St Johns River Level gauge is not influenced by the tide and it is located further upstream of the catchment. This is evidenced by a single peak in flows between the 24th and 26th of October (Figure 2-10). Peak level at the St Johns River Level gauge was observed at 05:00, approximately 4 hours after the rainfall peak at 00:45. This indicates a relatively quick catchment response to rainfall based on the catchment size and shape.

It should also be noted that peak rainfall and peak water levels and St Johns River Level gauge (which is not tidally influenced by tides) occurred at low and mid-tide. Therefore, the catchment was not tide locked at the time of peak water levels in upper Ryde. However, peak water levels at Monktonmead in the lower catchment were recorded at high tide and when the pumps were active. The pump in the culvert was activated at approximately 02:30, so flows out of the catchment may have been limited by pump capacity at peak water level in the lower catchment, which could have contributed to backing up and exacerbated river levels in northern Ryde.

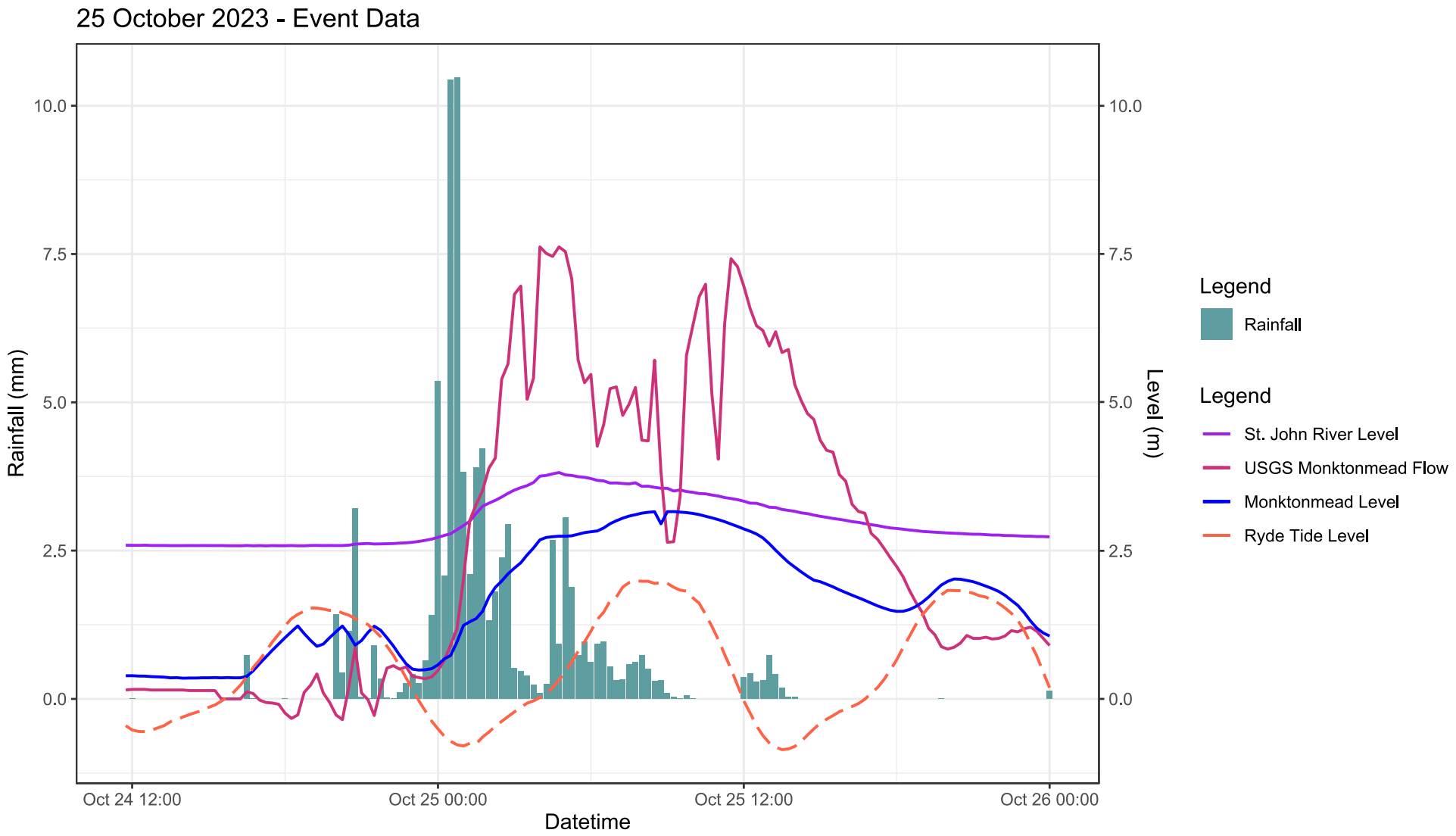
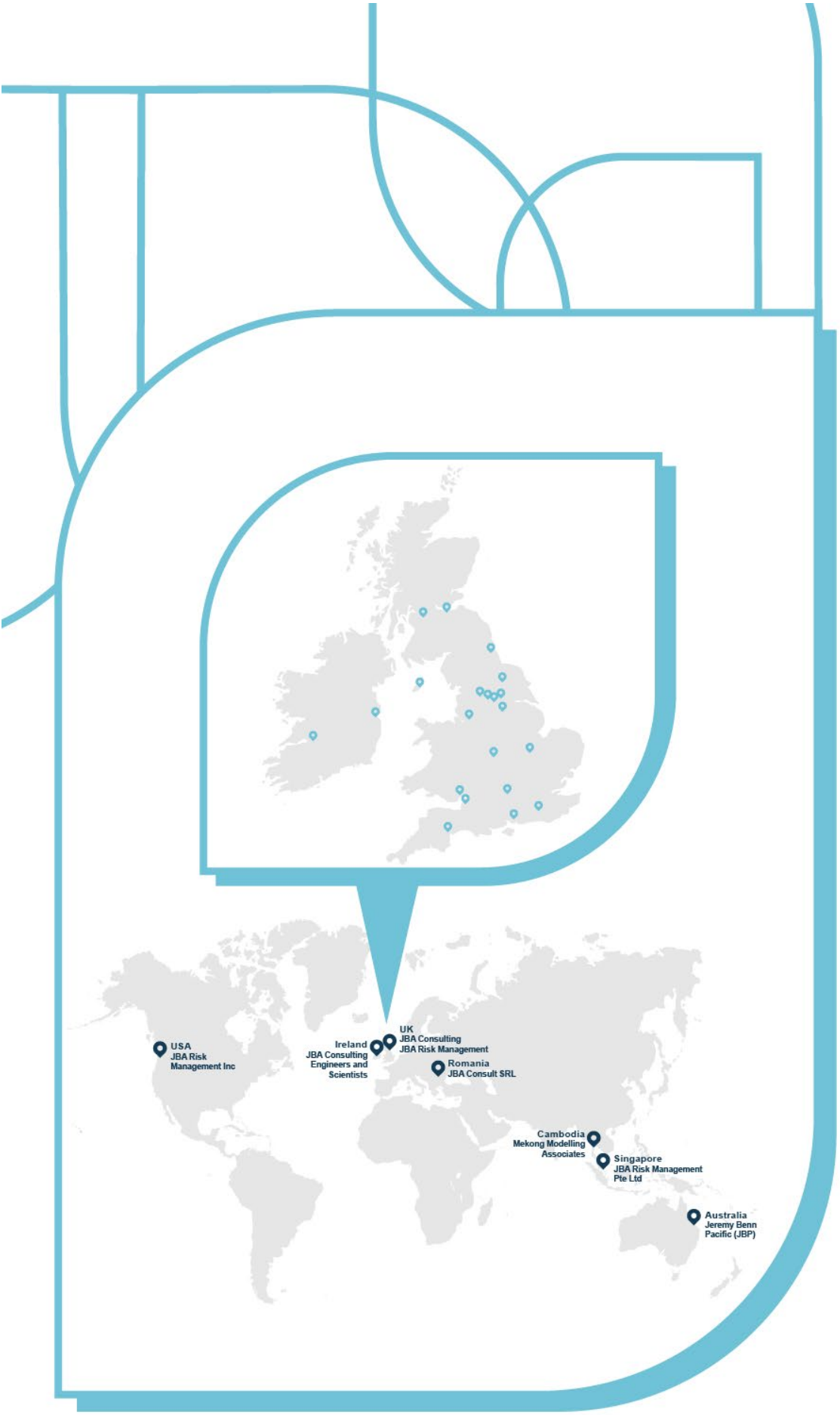

25 October 2023 - Event Data
Rainfall (mm)
Level (m)
10.0
7.5
5.0
2.5
0.0
Oct 24 12:00
Oct 25 00:00
Oct 25 12:00
Oct 26 00:00
Datetime
Legend
Rainfall
Legend
St. John River Level
USGS Monktonmead Flow
Monktonmead Level
Ryde Tide Level

Figure 2-10 Combined water level, tidal, and rainfall data for the October 2023 event in Ryde



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