Recreation Ground Emergency Exit, Rowlands Castle, Hampshire
Hydrological Survey

Report
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Water Resource Associates

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Signed on behalf of Water Resource Associates:

Dr Harvey J E Rodda
Project Director

MAIN CONTRIBUTORS

This assignment was carried out by the following team:

Harvey J E Rodda	Fieldwork, data collection GIS analysis, reporting and project administration
Giorgia Sacco	Figures, data collection, reporting and layout

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Cover Photographs [H J E Rodda]

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Summary

Scope of the Assignment

Rowlands Castle Parish Council commissioned a hydrological survey of the Recreation Ground in order to assess the risk of flooding relating to a proposed emergency exit.

Background Information

The Recreation Park is located in Rowlands Castle, East Hampshire, 5 km north of Havant, on the Hampshire/West Sussex Border. The Recreation Ground slopes north to south from 47m AOD to 38m AOD over a distance of 200m. The site of the proposed emergency exit will connect the south-east corner of the Recreation Park to the perpendicular road 'The Fairway'. The Fairway has experienced surface water flooding, most recently on 8th February 2019.

Hydrology

Rowlands Castle is situated on the northern edge of the Hampshire Basin bordering the South Downs and is within the catchment area of the Hermitage Stream. Although the Recreation Ground is underlain by the permeable Chalk bedrock it has superficial Head deposits with highly impermeable clay soil. This combined with the moderate slope and short grass of the playing fields will promote surface water runoff following extreme rainfall. The natural flow pathway from a 1.7 ha area of the Recreation Ground is directly to The Fairway at the proposed exit site

Local Flood Characteristics

During flood events water collects in a dip along The Fairway that coincides with the front drives of properties Number 8 and 10. Existing drains the drains in The Fairway lead to soakaways and Hampshire County Council has concerns over their performance.

Flood Estimation

Hydrological modelling was undertaken using the ReFH2 software from the Flood Estimation Handbook. This estimated the peak flow as 0.023 cumecs for the 1.7 ha contributing area following a 6-hour 100-year rainfall 0f 64.2mm. The overall flood hydrograph volume was calculated as 613 m^3. Additional simulations were undertaken to include the allowances for climate change ranging between a 5 and 40% increase to flows.

Flood Alleviation Measures

The proposed location for the exit in terms poses a significant increase in flood risk to The Fairway. Any exit would have to include properly designed flood alleviation measures to prevent an increase in flood risk. Flood alleviation would aim to divert surface runoff from the exit into a storage area with the combination of a pond and borehole soakaway being the preferred option.

Recommendations

Construction of exit should not go ahead without appropriate flood alleviation measures. RCPC need to select their preferred option, further ground investigations are required to identify the underlying geology and a design of the proposed exit is needed from which a detailed design of the flood alleviation measures can be submitted.

Glossary of Terms

km^2	square kilometres
mm	millimetres
m	metres
ha	hectares
m AOD	altitude as metres above ordnance datum
Cumecs	Cubic metres per second
DTM	digital terrain model
LiDAR	Light Detection and Ranging
GIS	Geographical Information Systems (mapping and spatial data management software)
catchment	area drained by a river

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1 Introduction

1-1 Background

Rowlands Castle Parish Council (RCPC) is currently considering a location for an emergency pedestrian exit from the Recreation Ground. WRA LLP was commissioned by RCPC, to undertake a hydrological survey of the village Recreation Ground in order to assess the risk of flooding at the site and in particular to properties downslope from the proposed exit along The Fairway. The survey would also consider measures which can be undertaken in order to reduce the risk if an 'emergency exit' was to be built.

This report has two sections, section 1 provides the background information to the area and introduces the flooding problem; section 2 provides details on the existing drainage, how the area could be affected by flooding if the emergency exit is constructed and what measures could be implemented to ensure the risk of flooding to properties is not increased.

1-2 Site Location and Topography

Rowlands Castle is a village in Hampshire 4km north of the town of Havant and immediately to the south of the South Downs National Park as shown by the Ordnance Survey map in Figure 1-1. The Recreation Ground is to the western side of the village (Figure 1-2), surrounded by residential properties along Links Lane to the west and south, The Fairway and to the south, The Peak to the east, Greatfield Way to the north and the proposed exit location is in the bottom right hand corner of the Recreation Ground at NGR SU73061076 as shown in the aerial photo in Figure 1-3. The proposed evacuation path will join the Recreation Ground to The Fairway over a width of approximately 4m between the trees shown in Figure 1 -4. The Fairway runs parallel to the southern perimeter of the Recreation Ground, and is bordered with occasional trees, a hedgerow, and an intermittent chain link fencing.

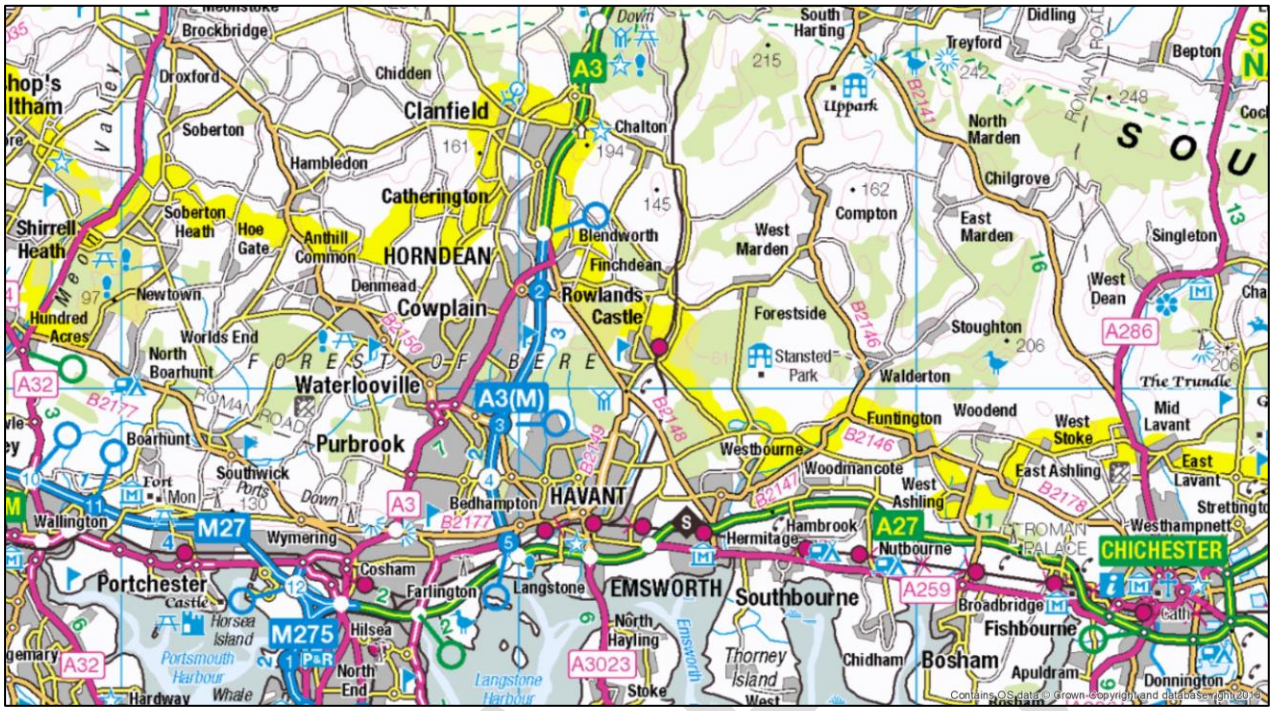

Figure 1-1 Rowlands Castle Location (background map OS Open Raster 1:250,000)

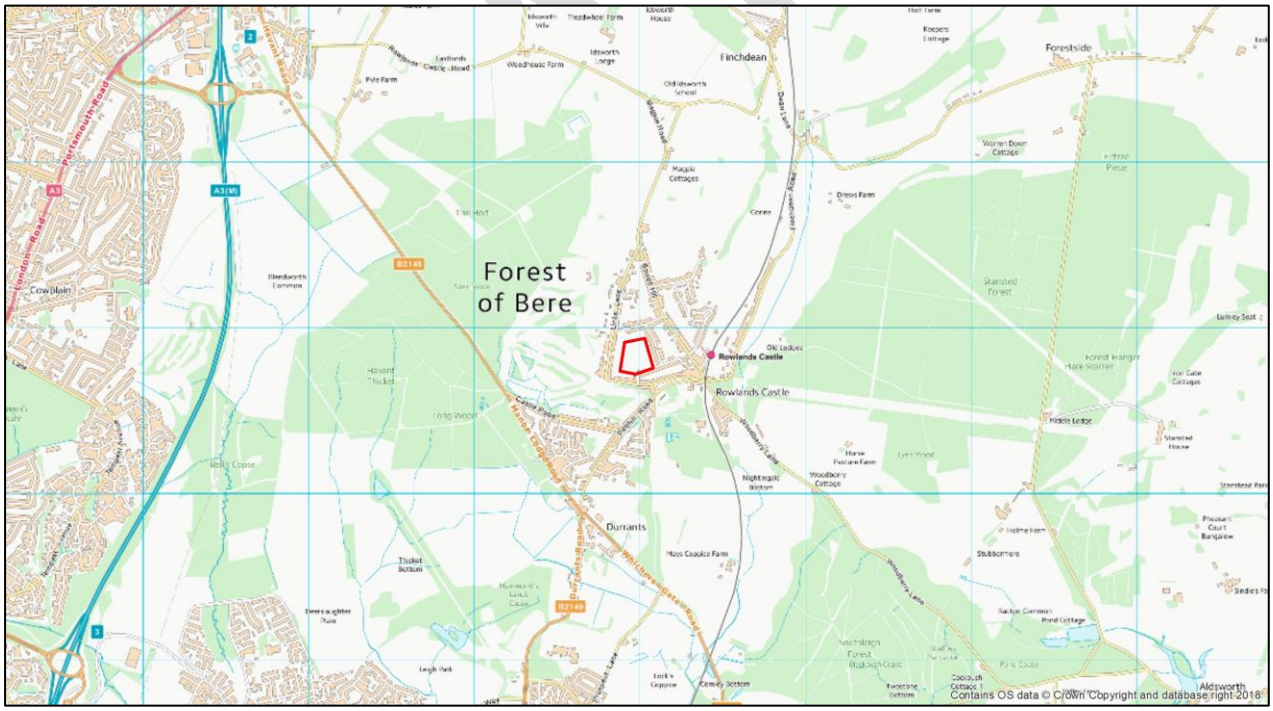

Figure 1-2 The Recreation Ground outlined in red (background map OS Open Raster 1:10,000)

Figure 1-3 Details of the Recreation Ground with the proposed exit location shown in yellow (background image source: Inforterra Ltd)

Figure 1-4 Proposed location of the emergency pedestrian exit to The Fairway.

The overall topography of the area was taken from a 1m cell resolution digital terrain model derived from an EA LiDAR airborne survey. This shows that the Recreation Ground slopes moderately from north to south from over 47m AOD to 38m AOD (Figure 1-5). The slope of the land can be clearly seen in the photo showing the houses along the eastern edge of the Recreation Ground (Figure 1-6). More detailed topography around the proposed exit location was obtained from a ground level survey made relative to the LiDAR data. The ground levels at the edge of the Recreation Ground at the proposed exit location were measured at 38.35m AOD. The ground drops steeply from the boundary over a sloping grass verge to The Fairway where the road level was measured at 37.62m AOD outside of Number 10. The driveways of the buildings slope further down from the road, with garage floor levels at 37.56m AOD for Number 8 and 37.28m AOD for Number 10.

The section of The Fairway at the point of the proposed exit was actually a low point in the road. The levels at the western end of the road opposite the pavilion were measured at 38.12m AOD and at the junction with The Peak levels were 38.0m AOD, some 0.38m higher than outside Number 10 The Fairway.

Figure 1-5 Details of the topography at the Recreation Ground

Figure 1-6 View of the Recreation Ground looking east showing the slope from left to right

1-3 Geology and Soils

The site is underlain by chalk bedrock of the Culver Chalk Formation, and is classified as Tarrant Chalk by the British Geographical Survey (BGS, 2019). However, at the location of the proposed evacuation path the Chalk is overlain by Head deposits which consist of clay, silt, sand and gravel. These are poorly sorted, stratified deposits that were formed up to 3 million years ago in the Quaternary Period and are commonly found on the lower slopes and in the valleys. Although the Chalk bedrock is highly permeable, the clayey Head deposits are more impermeable in nature. The thickness of the Head deposits is variable, there are no borehole records in the vicinity of the site which go through the Head into the Chalk, but a borehole 1.5 km to the south-west (Hampshire Reservoirs Site 18) gave 1.8m of Head above the London Clay formation. The Chalk gives way to younger clay silt and sand bedrock of the Lambeth Group about 200m south of the Recreation Ground. Details of the geology are shown in Figures 1-7 and 1-8.

According to Cranfield University the soils are classified as freely draining with a loamy texture over the clayey head deposits, and drain to local groundwater and rivers (Soilscapes, 2019). However, the soil at the site appeared to be clayey in texture and the ground surface was damp. A shallow borehole was sunk at the proposed exit site using a hand auger. This found clay down to 0.5m which was highly impermeable. The full thickness of the clay associated with the Head deposits was not found as the presence of flints prevented the auger penetrating further into the ground. A deeper borehole needs to be sunk using a mobile drilling rig to identify the thickness of the Head deposit above the Chalk bedrock in the south-eastern corner of the Recreation Ground as this would be key for the design of alleviation measures.

The permeability of the soil was tested by filling the borehole with water, and the level was observed to have only fallen 3mm in 40 minutes. This is equivalent to 0.011 m/day in the very slow drainage category (Bailey et al., 1980). The soils would be damp and remain impermeable for most of the year, although in summer the permeability in increased when clay soils dry out and cracks develop. The underlying Chalk is a major aquifer and has a high infiltration rate of up to 30 m/day (Shaw, 1983) so where water is able to percolate through the overlying clay it will rapidly infiltrate into the Chalk.

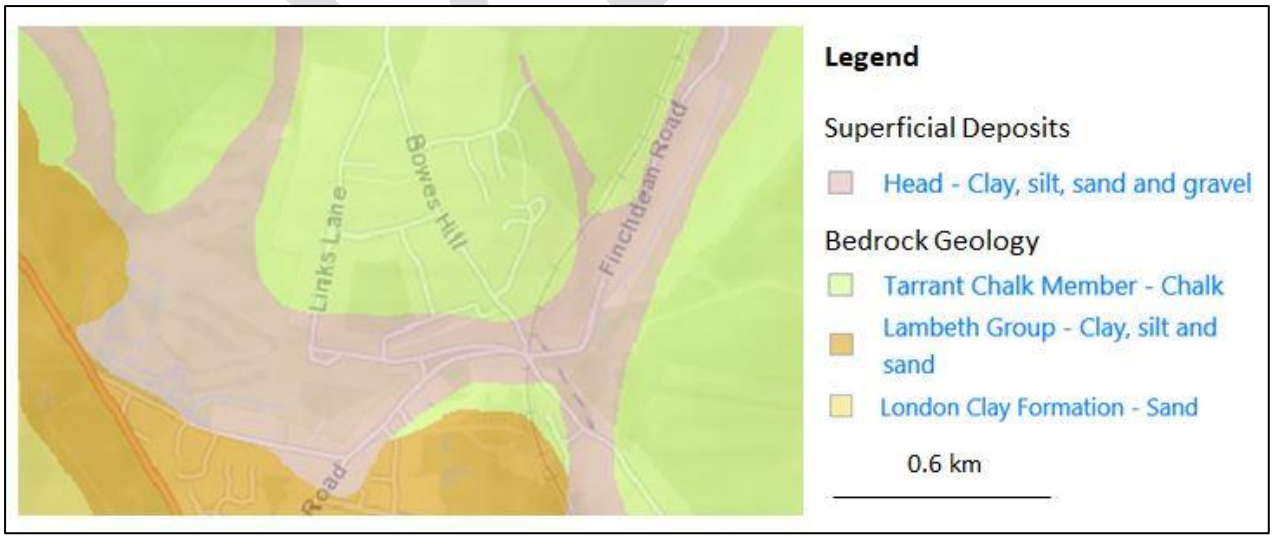

Figure 1-7 Details of the geology of Rowlands Castle. Source: BGS, 2019

Figure 1-8 Details of the soils at Rowlands Castle. Source: Soilscapes 2019

1-4 Hydrology and Flood Risk

Rowlands Castle is situated on the northern edge of the Hampshire Basin. At the foot of the South Downs. water drains off the South Downs via the Hermitage Stream and through Havant before entering the Langstone Harbour. The Hermitage Stream is a mainly impermeable catchment; principally underlain by the Reading Beds and London Clay (NRFA, 2019), draining an area of 17 km^2. The base flow index of the catchment is given by NRFA as 0.44 which is a value ranging between 0 and 1 to describe the groundwater component of flow. A value of 1 means the flow in the river is entirely groundwater fed, the lower value in the case for the Hermitage Stream shows a significant surface water component. The annual average rainfall of the catchment given by the Flood Estimation Handbook (1999) is 874mm. This value is relatively high for southern Britain and is partly due to the higher ground of the South Downs. The annual average losses through evapotranspiration are given as 323mm, meaning a total of 551mm will emerge as flow to the river on average each year.

Tributaries of the Hermitage Stream are shown on the OS maps to originate around 200m south-west of the site and would denote the boundary of the underlying Chalk with the impermeable clay bedrock of the Lambeth Beds and London Clay. These are at an altitude of around 34m AOD, more than 4m below the lowest level of the Recreation Ground. The impermeable clayey soils of the Recreation Ground combined with the moderate slope and the short grass cover would promote surface runoff at the site. This would be conveyed to the southern boundary, the soils were observed to be damp and the presence of leaves pushed up against the chain link fence (as in Figure 1-4) could be the result of water ponding.

The risk of flooding at the site can be gauged through maps provided by the EA. The EA flood zone map (Figure 1-9) indicates that the whole of the Recreation Ground is classified as being in flood zone 1 an area of low risk of flooding from rivers and outside of the extreme flood outline. The EA surface water flood risk map (Figure 1-10) shows areas of medium to low risk within the Recreation Ground and a high risk of surface water flooding along The Fairway at the location where the emergency exit is planned.

Flooding events been observed along The Fairway due to surface water runoff, either following intense rainfall over a short period or longer wet periods over many weeks. Notable dates of flooding which have been documented by residents include 24th June 2005, 17th January 2014, and 8th February 2019. Flooding also occurred during the Autumn and Winter of 2000/1 although the exact date is not known.

The rainfall event that occurred at beginning of February 2019 was described by the local Parish Council as an 'exceptional weather event'. After its occurrence, the Parish Office received several complaints with regards to surface water flooding in the village. According to readings, 37mm of rain was experienced in a 5-hour period. This led to flood water collecting in a dip that coincides with the front drives of properties Number 8 and Number 10 on The Fairway. Photos of the flooding are presented in Figures 1-11 and 1-12 According to the residents some of the water originated from the Recreation Ground and was silt-laden as shown in Figure 1-11. Water could have also flowed along The Fairway to pond in this location as it is a low point in the road, as indicated by the topographic survey (see Section 1-2). Flood water inundated the road in front of the properties and vehicles driving too fast through the water could have caused surges of water to run down the driveways of both houses, and into their garages. This has occurred with previous events, although during the flooding in 2001, the water level was high enough to overtop the driveways without the effect of passing traffic and was observed to flow into the garage and back garden of Number 10 The Fairway.

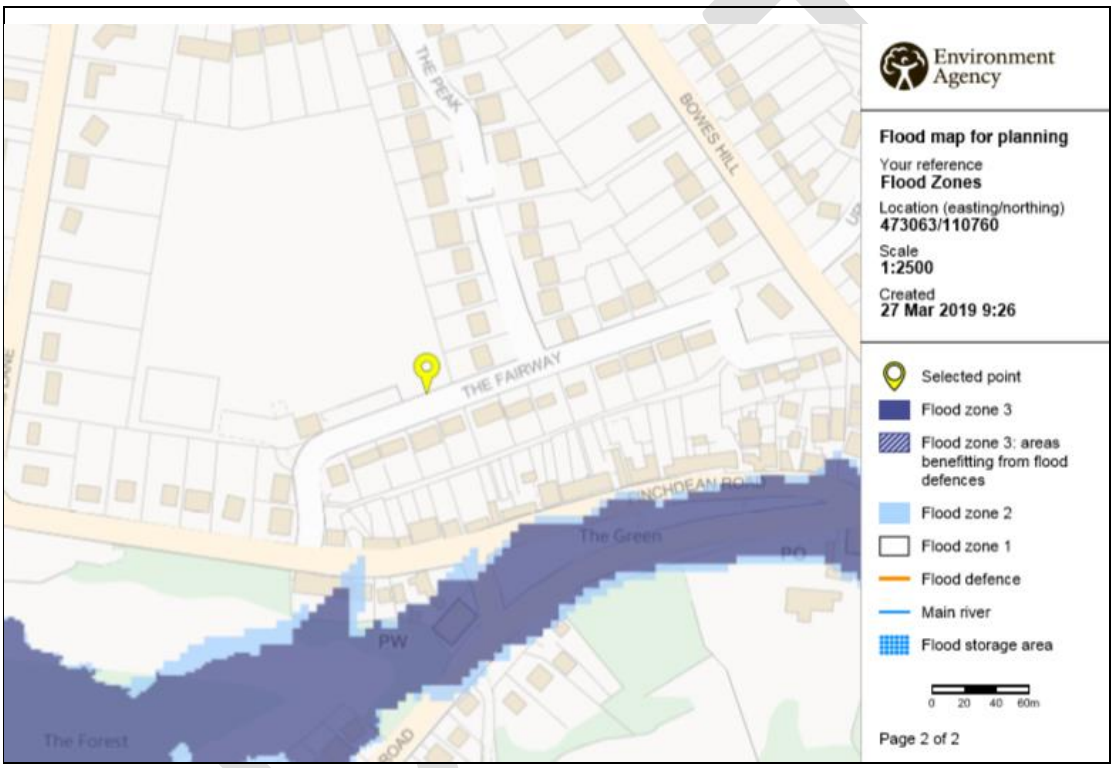

Figure 1-9 EA flood zone map © Environment Agency

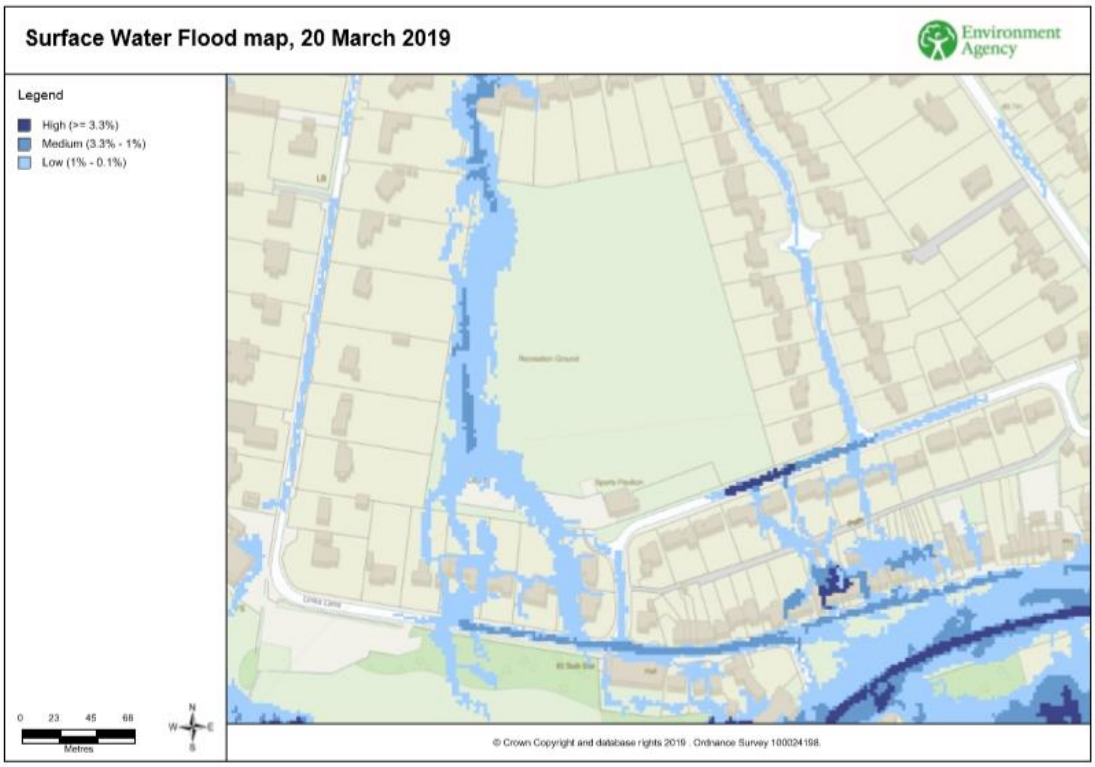

Figure 1-10 EA surface water flood map ***© Environment Agency***

Figure 1-11 Flooding along The Fairway

Figure 1-12 Flooding along The Fairway

Historical records of extreme rainfall for Rowlands Castle and the surrounding area have been obtained from the British Rainfall Digital Archive (Rodda et al., 2009). This includes observations of 24-hour rainfall back to 1866, many taken from rain gauges which are no longer in use. Observations are shown in Table 1.

Table 1. extreme rainfall observations for the area around Rowlands Castle from the British Rainfall Digital Archive.

Date	Location	Observed 24-hour rainfall	Distance from Site
26/12/1886	Idsworth House	92.7	0.7km N
02/01/1906	Stansted Park	64.3	3 km E
28/06/1917	Cowplain	66.3	2.7 km W
14/09/1927	Horndean	63.5	3.7 km NW

2 Implications of the Proposed Exit

2-1 Proposed Exit Location

Although a specific location and design for the proposed exit has not yet been finalised, a more specific assessment of the hydrology for the approximate location of the exit was undertaken. Using the 1m DTM and cell based modelling within the geographical information systems (GIS) software package ArcGIS, the location of flow pathways were identified. These show the route that water would take over the surface

where the upstream contributing area exceeds a certain value. For the case of the current study this was set at 1 ha. The location of the flow pathways, shown in Figure 2-1 demonstrates that the site of the emergency exit corresponds almost exactly to the origin of a flow pathway which would then pass across the Fairway and between the properties at Number 8 and Number 10. The GIS analysis also allows the calculation of the actual contributing area to the exit location, this is also shown in Figure 2-1 and covers an area of 1.74 ha including the eastern part of the Recreation Ground and properties on the western side of The Peak.

Figure 2-1 Aerial photograph showing flow pathways

2-2 Existing Drainage Infrastructure

During the site survey a number of drains were observed in The Fairway on both the Recreation Ground side and the side with residential properties. The locations of these were confirmed by Hampshire County Council. The drains (gullies) convey the surface water into soakaways. Hampshire County Council provided a map showing the location of these (Figure 2-2) but also commented that the soakaways in the low point of The Fairway are struggling to cope. Information on the depth of the soakaways has not been provided but given the impermeable nature of the soil, unless the soakaways were excavated into the permeable Chalk beneath the Head deposits they would not function. According to the County Council the

drains and soakaways have been in place since before 1976 when the road was formerly adopted, hence they would not have been designed based on any rigorous hydrological modelling which has only been available since 2016. Prior to this urban drainage was notionally designed to be able to convey the a 5-year rainfall. The drains would also have been designed for road drainage and not to accommodate additional water from the Recreation Ground. Information provided by Southern Water (Figure 2-3) also confirmed there were no sewers along The Fairway. A foul water sewer orientated along The Peak crosses The Fairway flowing in a north-south direction and is joined by a foul sewer serving the properties of The Fairway flowing north-east but located to the south of the houses.

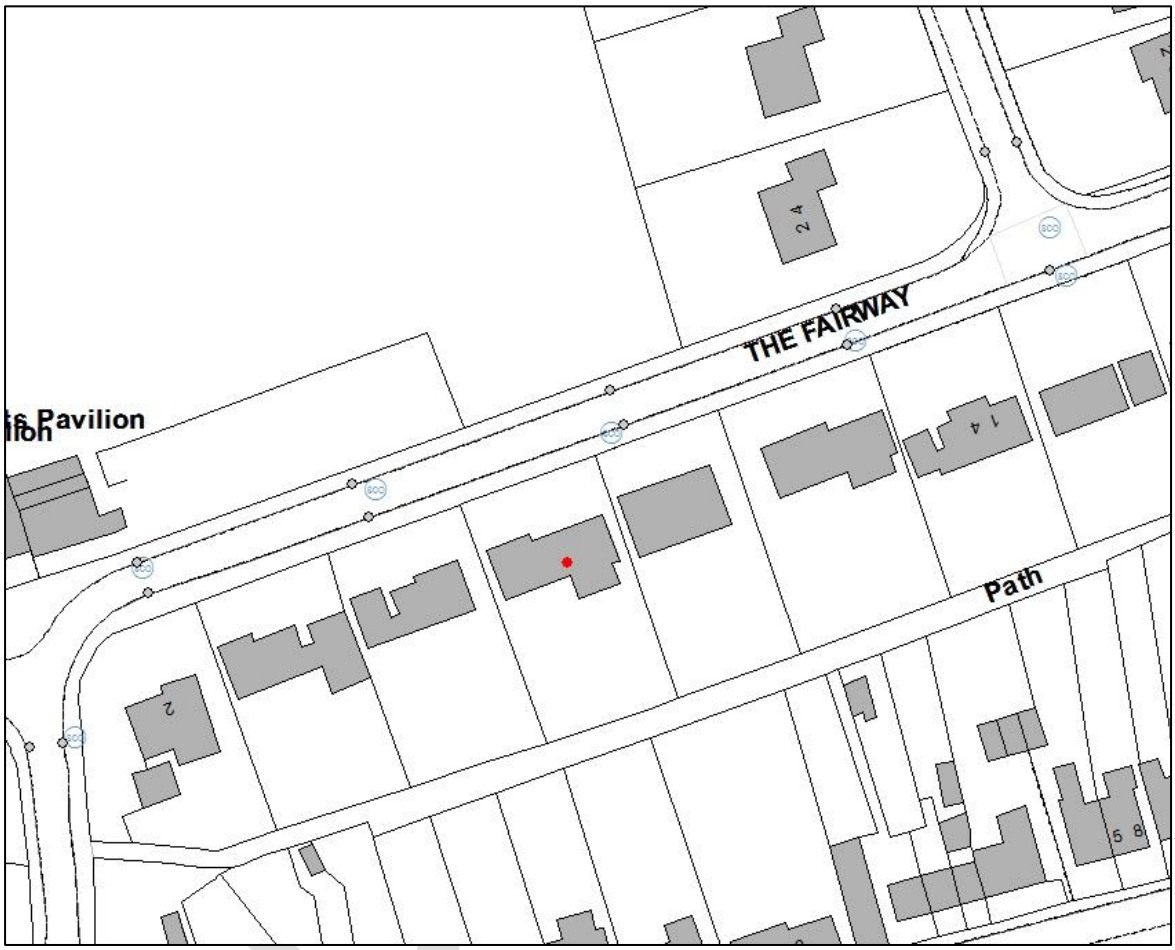

Figure 2-2 Locations of drains and soakaways along The Fairway

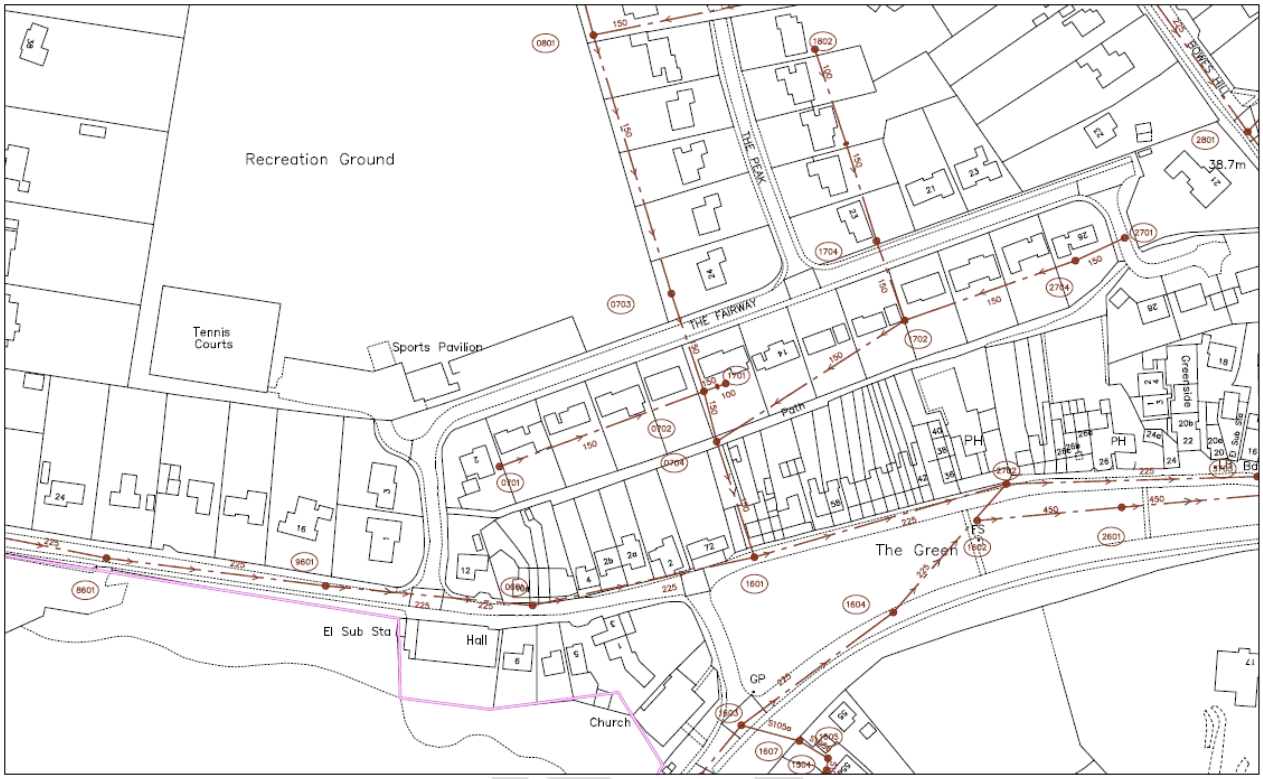

Figure 2-3 Southern Water foul sewer locations

2-3 Design Flow Estimates

For any flood study, a key component is to estimate how much water will flow at a particular location under extreme conditions. The normal approach is to use an extreme event classified in terms of how likely it will occur, namely the probability. Estimates are made of the 100-year flood, which is the maximum flood which will occur on average just once in a period of 100 years. Such calculations are commonly undertaken based on observed flows at gauging stations when flood estimates are required for rivers. In the case of Rowlands Castle where flows are required for a very small hillslope catchment, hydrological modelling using a rainfall-runoff approach is normally applied. This is where the 100 year rainfall for a particular duration and a parameter describing the nature of the catchment are used to define the flood hydrograph; a representation of the estimated flow over time. The Flood Estimation Handbook (Institute of Hydrology, 1999) provides standard methodology for generating such estimates and is the approved method as stated in the latest sustainable drainage system guidance (Woods-Ballard et al, 2015). The most recent version of the rainfall-runoff model from this approach, the ReFH2 (WHS, 2016) was applied.

The software can specify a critical duration for the rainfall based on the characteristics of the catchment, although normally for drainage design studies the resulting flows from a 6-hour duration 100-year rainfall, including an allowance for climate change are required. The output hydrographs from the rainfall-runoff modelling are shown in Figure 2-4. The associated rainfall for the 100-year 6-hour duration storm was defined as 64.2mm, almost twice the amount observed in February 2019, but commensurate with the observed values shown in Table 1. This produced a peak 100-year flow of 0.023 cumecs (23 litres per second) and an overall hydrograph volume of 613 m^3.

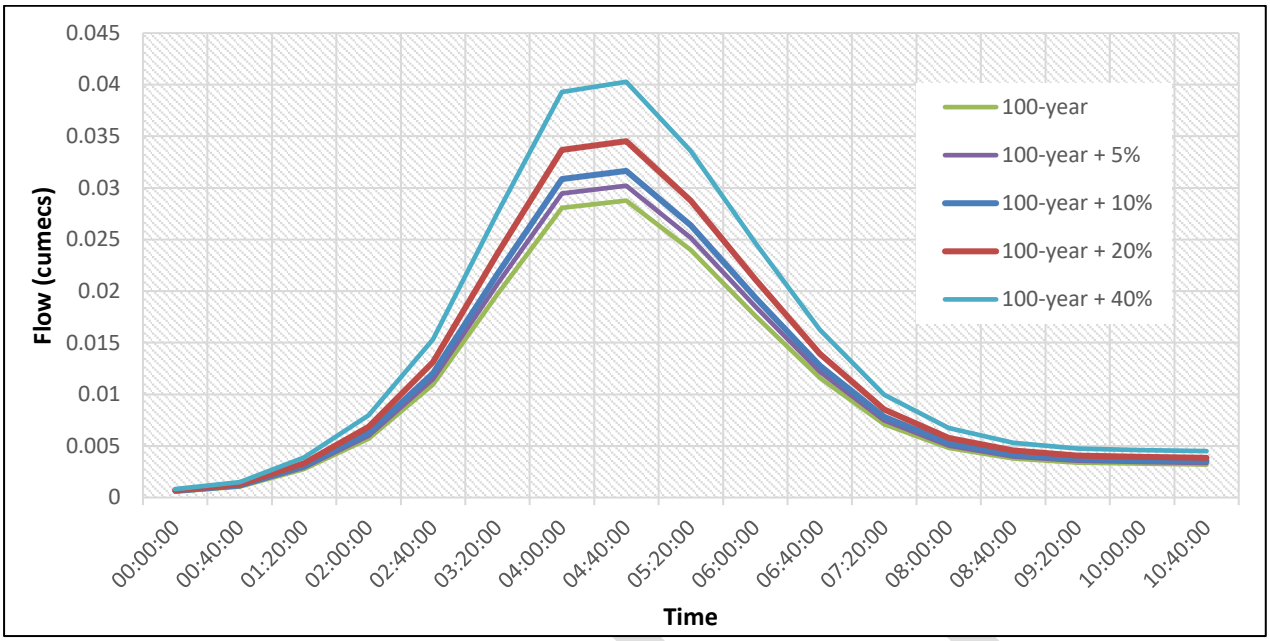

Figure 2-4 Design hydrographs for the proposed exit location

2-4 Potential Flood Alleviation Measures

The proposed exit location is very unfavourable in terms of the risk of flooding to properties along The Fairway based on the assessment of the hydrology as shown in Figure 2-1. Other similar locations are where the flow pathways are shown in the location of the tennis courts to the west of the Recreation Ground. Currently water flowing from the Recreation Ground as surface runoff will possibly pond at the southern boundary and gradually issue out through the chain-link fence and hedge to the verge of The Fairway. With the emergency exit in the form of a ramp to The Fairway there would be no impedance to the water and surface runoff would flow freely directly onto The Fairway.

Flood alleviation measures therefore must be included as part of the construction of the exit. The basis of any flood alleviation at the proposed exit location would be to ensure the surface runoff from the 1.7 ha contributing area is not conveyed through the exit onto The Fairway as under the design flood scenario this would result in flooding of The Fairway and the residential properties. The most effective way would be to convey water at a point upstream of the proposed exit away from the exit slope and to provide detention of the design storm volume in the far south-eastern corner of the Recreation Ground.

The options would be to have a surface detention basin which would provide a pond and seasonal wetland or to provide sub-surface detention through conveying the excess water into the ground water via one or more borehole soakaways through the Head deposits into the Chalk or a combination of both. A hybrid system with a combination of the pond and soakaways would be the preferred approach given that the storage volume would need to be at least 613 m^3 so a pond on its own would need to cover a large area, but the presence of pond / wetland area would provide additional amenity value to the area and enhance biodiversity. This system would include a permanent pond and a larger surrounding buffer area which could accommodate excess water in the event of a storm. This volume would be allowed to flow through an overflow pipe into the borehole soakaways.

The collection of the surface runoff could be through a gravel trench into a perforated corrugated plastic pipe running along the base of the trench. This would act as an interceptor drain to capture surface runoff from the Recreation Ground before it reached the exit to The Fairway. According to ADAS drainage

capacity charts (Bailey et al., 1980) a 0.1m diameter pipe at a gradient of 2.5% has a capacity of 23 litres per second so would therefore be able to convey the 100-year flow.

The gravel would act as a filter to remove sediment but would also maintain the current ground surface. Other landscaping would need to be in place such as in the form of a raised bund around the edge of the pond to ensure water accumulating in the pond area does not flow back towards the exit. An outline sketch of the proposed measures is shown in Figure 2-5. This just assumes a hypothetical location and size of the exit since a design has not yet been provided. Likewise, the size and location of the pond and drains are purely indicative. Another sketch with cross sections of all the features is shown in Figure 2-6.

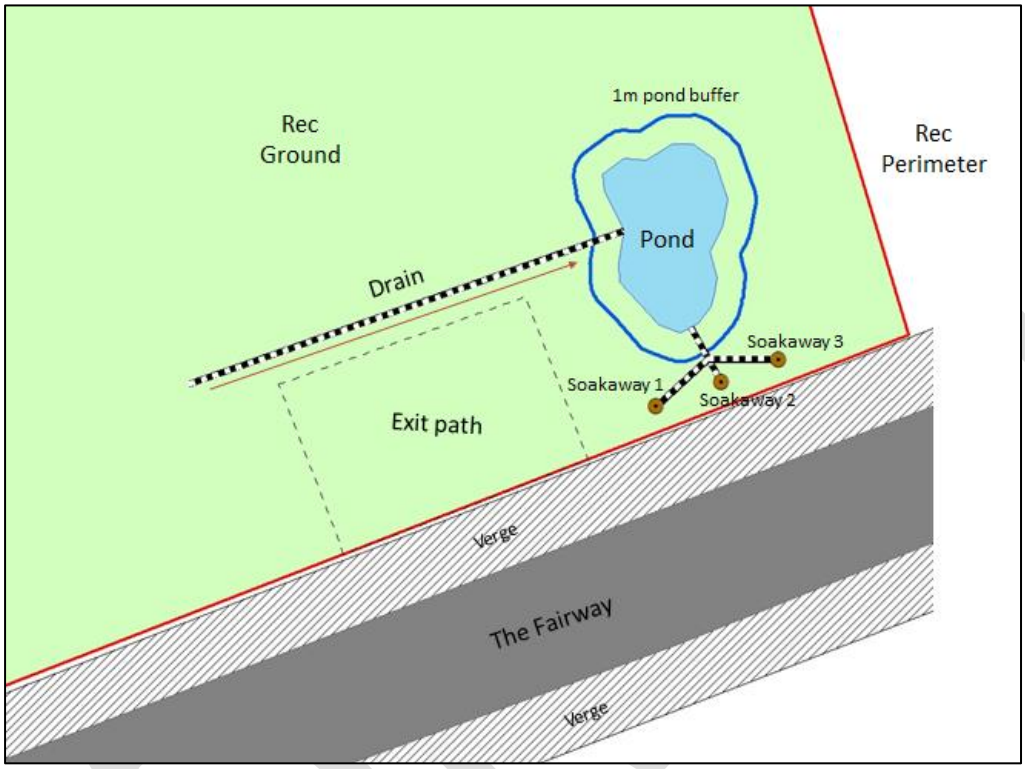

Figure 2-5 Sketch map of the potential flood alleviation measures

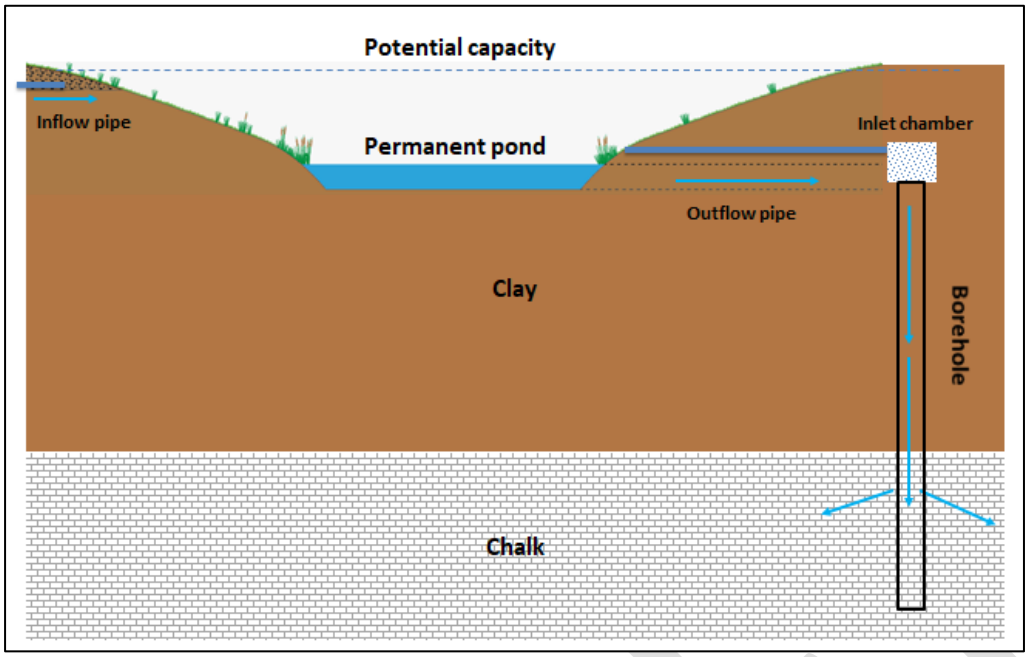

Figure 2-5 Indicative cross section of the potential flood alleviation measures

2-5 Recommendations

The alleviation measures given in section 2-4 are only recommendations and do not represent a final design. Further steps are required before a final design of flood alleviation measures is submitted. Firstly, RCPC would need to identify an exact location of the emergency access and provide a proper design including details of the size, materials and gradient of the exit. RCPC would also need to select the preferred option for flood alleviation and this would be informed by the results of sinking a deeper borehole in the proposed location to find the thickness of the overlying clay and the depth to groundwater in the Chalk. Through discussions with the County Council agreement should be reached on the climate change allowance to use. Finally, a detailed design of the alleviation measures will need to be submitted which includes the dimensions of all the components, listing of materials and specifications for the construction to ensure minimal environmental impact.

2-6 References

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