

Parrs Wood High School

Flood Risk Assessment

FINAL DRAFT REPORT

Department for Education



Department
for Education



FINAL DRAFT REPORT

May 2018

Report Overview

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Wilmslow Rd, East Didsbury
M20 5PG, Manchester, United Kingdom

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Table of Contents

Executive Summary	1
Methodology	3
Site Overview	4
<i>General Information and School Background</i>	<i>4</i>
<i>Location</i>	<i>4</i>
<i>Buildings, Facilities and Assets</i>	<i>4</i>
Local Hazard Assessment	6
<i>River flooding</i>	<i>6</i>
<i>Surface Water Flooding.....</i>	<i>10</i>
<i>Groundwater Flooding.....</i>	<i>11</i>
Flood Vulnerability Considerations	12
<i>General considerations</i>	<i>12</i>
<i>Sixth Form</i>	<i>12</i>
<i>Music Block</i>	<i>14</i>
<i>Sports Hall.....</i>	<i>14</i>
<i>Main School Building.....</i>	<i>14</i>
<i>Other Buildings</i>	<i>15</i>
<i>Sports Grounds</i>	<i>15</i>
Loss Assessment	16
<i>Property Damage and Business Interruption Values and Considerations.....</i>	<i>16</i>
<i>Probable Maximum Loss (PML) Assessment</i>	<i>17</i>
Risk Mitigation	22
<i>Recommendations Summary Table.....</i>	<i>22</i>
<i>Recommendations Criteria.....</i>	<i>23</i>
<i>Cost Effective Loss Prevention and Protection Recommendations.....</i>	<i>24</i>
<i>Cost/Benefit Analysis</i>	<i>33</i>
<i>Good Practice Advice on Business Continuity and Emergency Response Guidelines</i>	<i>36</i>
Appendix Section	40
<i>Limitations</i>	<i>40</i>
<i>Third Party Disclaimers</i>	<i>41</i>

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Executive Summary

Introduction and Background

The Department for Education (hereafter referred to as 'DfE') is a department of Her Majesty's Government and is amongst other items responsible for child protection, education (compulsory, further and higher education), apprenticeships and wider skills in England. In this context, the DfE provides funding to several thousand academic institutions across England. As part of the DfE's resilience strategy, the department has investigated the exposure of many of their key institutions and schools to flood hazard and is now interested to further assess the vulnerabilities of some of their and academies most exposed assets to flood hazard.

In this context, the Strategic Risk Consulting team of Willis Towers Watson has been requested by the DfE to develop a pilot flood catastrophe risk assessment of Parrs Wood High School, East Didsbury - Manchester, with the objective of providing a flood risk engineering assessment report including Probable Maximum Loss Estimates as well as Loss Prevention Recommendations for the site.

The flood risk engineering study involves a site-visit of the site's premises of Parrs Wood High School, a flood hazard review and assessment of the vulnerabilities observed during the survey. The findings of the assessment are summarised below.

Key Findings

Flood Hazard Assessment

A number of flood hazard databases were used to assess the extent and likelihood of a potential flooding from the nearby river and other sources which could impact the school's grounds taking into consideration detailed elevation/terrain profiles and hydrodynamic modelling of the local conditions. The assessment shows that flooding is likely to occur in the school's sports grounds.

Localised surface water flooding with depths up to 300mm could occur in the vicinity of the main electrical area entrance. This level of flooding is associated with return period of 1 in 30 years (3.3% likelihood in a given year) and higher water accumulation is possible in the north side of the campus within return period of 1 in 100 years to 1 in 1000 years (1% to 0.1% likelihood in a given year respectively)

There is a limited potential for groundwater flooding to basements at the site, due to the local terrain which could act as a collector of groundwater and raise the underground water table.

Vulnerability Findings

Critical flood exposed areas are considered to be the sports grounds - for what it concerns riverine flood risk – and the main basements / utilities area. There are two main basements on site, one in the sixth form building and one in the music block. Both are used as boiler rooms / storage area / server rooms. The lower ground floor of the main school building hosts the main electrical rooms with PV inverters and medium voltage dry transformers.

Based on the findings from the hazard analysis and the site survey, Probable Maximum Loss (PML) flood scenarios and a prioritized list of recommendations are provided to the DfE.

Loss Scenarios

The school's experience and loss history indicate that flood events do occur. Based on the flood hazard and vulnerability assessments of this report, following a period of heavy rains, we can consider two types of potentially correlated hazard.

Riverine Flood: the volume of water in the River Mersey could increase and flood waters could hit the sports ground at Parrs Wood High School. The main school's buildings are significantly elevated when compared to the expected water level and flood depth, and there is little likelihood of flood propagating to other areas.

Surface Water Flood: a medium to low level surface water runoff flooding risk exists at the school and could impact the Main Building Electrical Rooms, Transformer Rooms and PV system inverter room. It should be noted that in a more remote scenario (1:100 to 1:1,000 year return period), the Music Block, Main Boiler Room, the Potting Shed and Boiler Room could also be considered at risk (ref: Local Hazard Assessment Section).

The Probable Maximum Loss that could result from an event of this nature has been evaluated as follows:

Scenario Summary (Riverine Flood and Surface Water Flood)	Estimated Loss (GBP)
Property Damage Loss	190,000
Overall Estimated Downtime:	3 months

Risk Mitigation

The main loss prevention findings are:

- Overall, the general status of the facilities at the time of the survey appeared visually of high standard and the design philosophy appeared to be appropriate to the level of flood hazards.
- Potential risk improvement actions have also been identified from the survey. These recommendations can be used to improve and optimize Parrs Wood High School's risk management strategy and reduce the potential impact of a catastrophic event.
- 9 recommendations are offered to mitigate the potential losses for the location following a flood event
- Currently the school's emergency response plan is not accommodating for flood hazard, and detailed considerations have been summarized in order to further support Parrs Wood's catastrophic risk resilience management.

The following recommendations have been proposed to assist Parrs Wood High School along the risk mitigation process (sorted by priority).

Rec. Number	Name	Priority	Complexity	Cost Benefit
FL 2018.01	Housekeeping	■■■■■	■□□□□	■■■■■
FL 2018.09	Flood Emergency Response Plan	■■■■■	■□□□□	■■■■■
FL 2018.02	Increase the Electrical Equipment Elevation	■■■□□	■■■□□	■■■■■
FL 2018.03	Increase the Boilers Elevation	■■■□□	■■■□□	■■■■■
FL 2018.04	Temporary Flood Protection Measures	■■■□□	■■■■■	■■■■■
FL 2018.08	Emergency Diesel Generator Agreement	■■■□□	■■■□□	■■■□□
FL 2018.05	Mobile Flood Protection Equipment	■■■□□	■■■■■	■■■□□
FL 2018.06	Water Drainage System	■□□□□	■□□□□	■■■□□
FL 2018.07	Astro football pitch flood protection design	■□□□□	■■■■■	■□□□□

Methodology

The methodology followed for this risk assessment is summarised below.

The flood risk engineering study involves a site-visit of the site premises i.e. Parrs Wood High School, a flood hazard review and assessment of the vulnerabilities observed during the survey.

The flood hazard review includes a detailed research into the flood hazard exposures for the region, the site and its premises to determine the local hazard including local flood defences. The assessment of the local flood hazard is based on a selected return period event as a basis for the flood risk assessment. This involves a high-level review of readily available hydrological data, historical flooding reports and other available information where relevant to gain an independent view of the flood hazard.

The vulnerability assessment of the site includes a high-level review of available site documentation including any existing construction survey reports, information of the local drainage systems, flood mitigation measures and risk transfer arrangements. The documentation review includes any available architectural and structural drawings for the buildings and main support structures to understand the original design intent.

During the site survey our natural hazard engineers assess the vulnerability of the site to flood hazard. The survey involves an on-site initial start-up meeting to explain the purpose of our survey and to understand the nature of the site operations, maintenance history and any past problems. During this meeting, critical areas of the building as well as equipment necessary for continued operations were identified. This is followed by a walkthrough survey of the school to visually inspect key accessible areas such as buildings and on-site utility equipment essential for operations. The inspection focuses on the visually apparent 'as is' physical condition of these assets with respect to flood risks and the protection of these facilities. If available information on business continuity plans, key equipment, and expected repair or replacement times are collected to aid the business interruption estimates.

Based on the findings from the hazard analysis and the site survey, Probable Maximum Loss (PML) flood scenarios are developed split by Property Damage (PD) and Business Interruption (BI).

The final step of the assessment is the provision of an itemized list of recommendations to help DfE consider potential risk improvement measures to reduce future risks from flood hazards with site photographs documenting the assets inspected on-site

Please note that this analysis of PD and BI losses is an order-of-magnitude type of estimate based on our natural hazard assessment combined with readily available information, the site inspection and discussions with site personnel. No structural analysis, performance calculations were undertaken as part of this study.

Site Overview

General Information and School Background

Parrs Wood High School is a mixed 11-18 community school with a Sixth Form. The original school opened in 1967 as an 11-18 co-educational comprehensive situated in the South Manchester suburb of Didsbury. The main school accommodates **1500** pupils in years 7 to 11, whilst **400** Sixth Form students are mainly based in Parrs Wood House, an 18th Century Georgian Villa.

The majority of the school's buildings have been completely rebuilt in 2000 and its facilities are used by a wide range of community groups including being a base for the Bobby Charlton International Summer School programme.

Location

Parrs Wood High School occupies a 192,797m² site adjacent to the River Mersey within the heart of Didsbury, a suburban area of Manchester city (Latitude 53.408382, Longitude -2.217056). The location of the School is shown below.

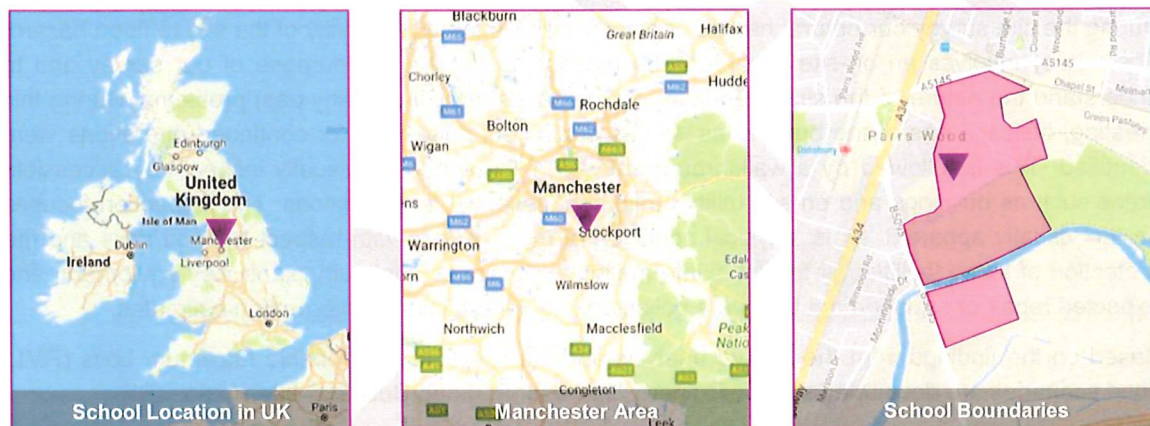


Figure 1 – Parrs Wood High School Location overview

Buildings, Facilities and Assets

Parrs Wood High School comprises 4 key buildings on the northern side and a football pitch on the southern side which includes an all-weather football field with synthetic grass.

A brief description of each building is reported below:

1. **Sports Hall** – The Sports Hall is a 1999 2 stories steel frame building with metal sheeting and internal masonry walls (2,858 sqm). The sports hall is equipped with an event room (empty at the moment of the survey), a small dining room, and the main auditorium room (including 10 rows of seats).
2. **Sixth Form** - The Sixth Form is a 2 stories masonry building composed of two sections connected by a corridor: Parrs Wood House (a 1779 Grade two listed building) and a newer extension with white wood cladding on the walls. The building hosts offices, classrooms and meeting rooms. A construction site was observed at the time of the survey as restoration work were taking place at the Parrs Wood House.

3. **Music Block:** The Music Block, built circa 1960, includes the kitchen and the canteen. Part of the building is rented to a third party (hairdresser shop). This building is connected to the main school building via a corridor.
4. **Main School Building:** The Main School building is a 3 storeys masonry building:
 - a. *Ground Floor – Key Areas:* this floor includes 3 groups of classrooms (Science, Art and Technology and Mathematics), together with the school office and the library / learning centre.
 - b. *First Floor – Key Areas:* First floor hosts the Science, Technology and English classrooms. In addition, 5 computer rooms are located on this floor.
 - c. *Lower Ground Floor – Key Areas:* The lower ground floor hosts the main technology classrooms / laboratories (3 of them equipped with carpentry and metalworking tools and machinery) together with the other languages area.
5. **Other Buildings**
 - a. *Synergy Centre:* built circa 1910 and located in the northern area of the site. The 2 storeys – 36sqm masonry building mainly hosts classrooms and a small server room on the ground floor
 - b. *Potting Shed:* This 80sqm 1 storey masonry building hosts a greenhouse, a small warehouse and a small boiler room.
 - c. *Memorial Garden Building:* This facility is a 1949 1 storey - wood frame building with gable roof. The building hosts a small boxing gym, a kitchen and a minor server room.
6. **Sports Ground:** The sports ground is located in the along the River Mersey. A portion of it is dedicated to an all-weather synthetic grass football pitch, built 10 years ago and provided with lights and fences. A second Sports Ground is located south of River Mersey, and it is protected by flood defences as shown in the next section.



Figure 2 - Main campus and buildings

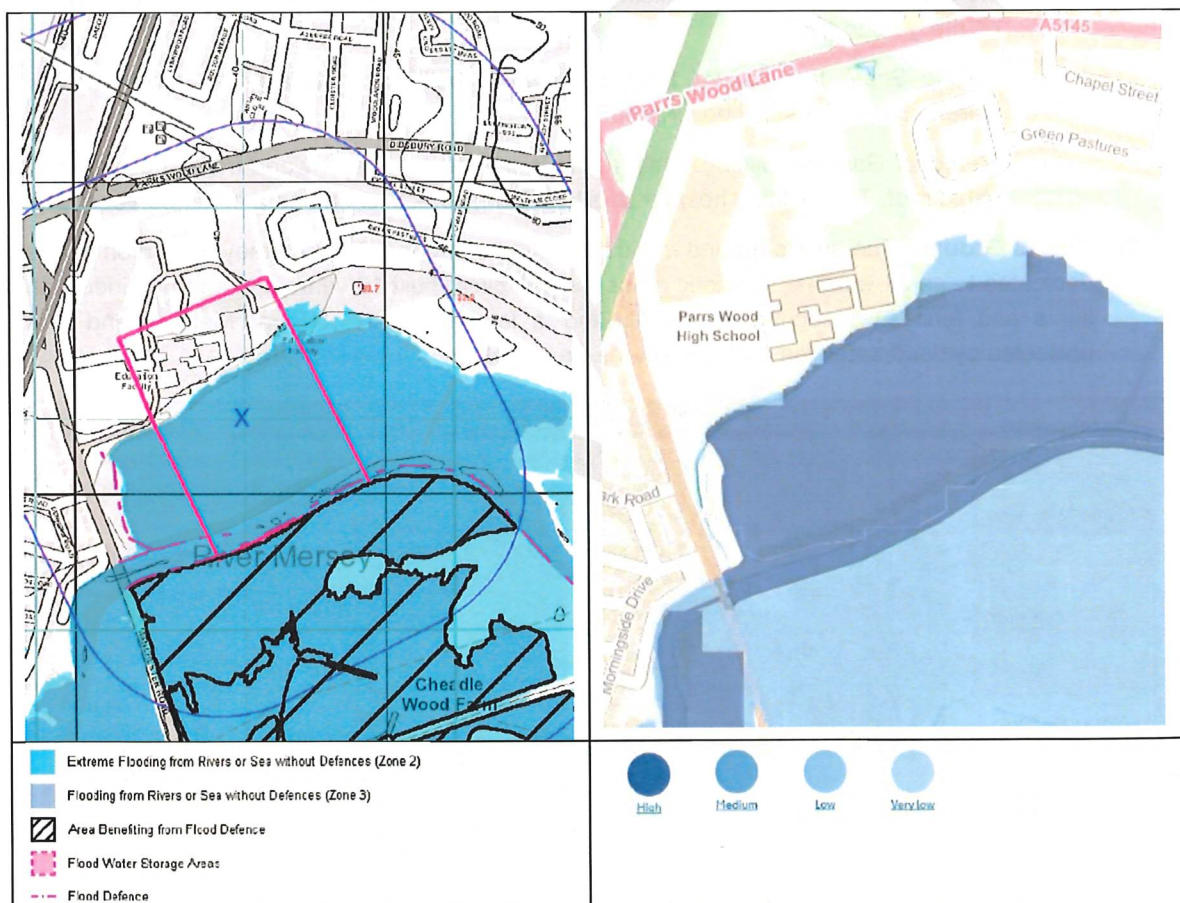
Local Hazard Assessment

The flood hazard in East Didsbury consists of 3 separate elements, river flooding from the nearby rivers and channels, surface flooding from water run-off due to the steep terrain and groundwater flooding due to the possible high groundwater levels.

River flooding

The main risk from river (fluvial) flooding comes from the nearby river (River Mersey). It was reported that the football pitch was flooded by the river in 2010 and in 2016. The River Mersey flows south of Parrs Wood High School, along the sports ground.

A number of flood hazard databases were used to assess the extent and likelihood of a potential flooding from the nearby river and any other source which could impact the school's grounds taking into consideration detailed elevation/terrain profiles and hydrodynamic modelling of the local conditions. The assessment shows that flooding is likely to occur in the school's sports grounds, with the potential extent of the flood presented in the figures below.



The return period associated with the risk rating on the figure to the right (government flood risk information) is as follows:

- a. High risk – 1 in 30 year likelihood or 3.3% chance in occurring in the next year
- b. Medium risk – return period between 30 and 100 years or 1% to 3.3% likelihood in any year
- c. Low risk – likelihood of a flood occurring between 0.1% and 1% in any year – return period of 100 to 1000 years
- d. Very low risk – return periods of greater than 1000 years.

This takes into account the effect of flood defences in the area. These defences reduce but do not completely stop the chance of flooding as they can be overtopped, or fail.

Historical Information

Historic flood information supports the risk highlighted above as data indicates that the river capacity has been exceeded in the past resulting in the flood event described below.

In 2010 floods hit the playing fields at Parrs Wood High School, as a result of the high volume of water in the River Mersey following a period of heavy rain, which forced the Environment Agency workers to open the sluice gates at Millgate Lane, just behind Fletcher Moss Park.

The banks of the Mersey between Parrs Wood High School and Millgate Lane were rebuilt by the Environment Agency in 2000 after a public consultation with over 1,000 east and south Didsbury residents. The Agency also considered building a flood channel through Bradley fold allotments on Ford Lane to alleviate rising waters at local flood hotspots, but the plan was not approved.



Figure 4 – Sports Ground 2010 flood picture (source: manchestereveningnews.com)

In November 2016 a flood event was observed, with the playing grounds being flooded. During the latest event, a flood depth of 10 feet was observed as reported by the site personnel during the survey. As a consequence, the area was unavailable for several weeks. Debris removal and clean-up costs following that flood event were in the ballpark of 20,000 GBP as reported by the site team during the survey.

Site Elevation and Flood Defenses

River Mersey is located along the south perimeter of the sports grounds. The elevation profile from the river to the main school buildings proximity mitigates the flood risk. The figure below shows an approximated elevation profile for the river and the school. It can be observed that the school's main building's lower ground floor (the lowest area of the school's facility) is generally elevated to above a 1 in 100 year return period flood level (more than 3 meters high when compared to the river level).

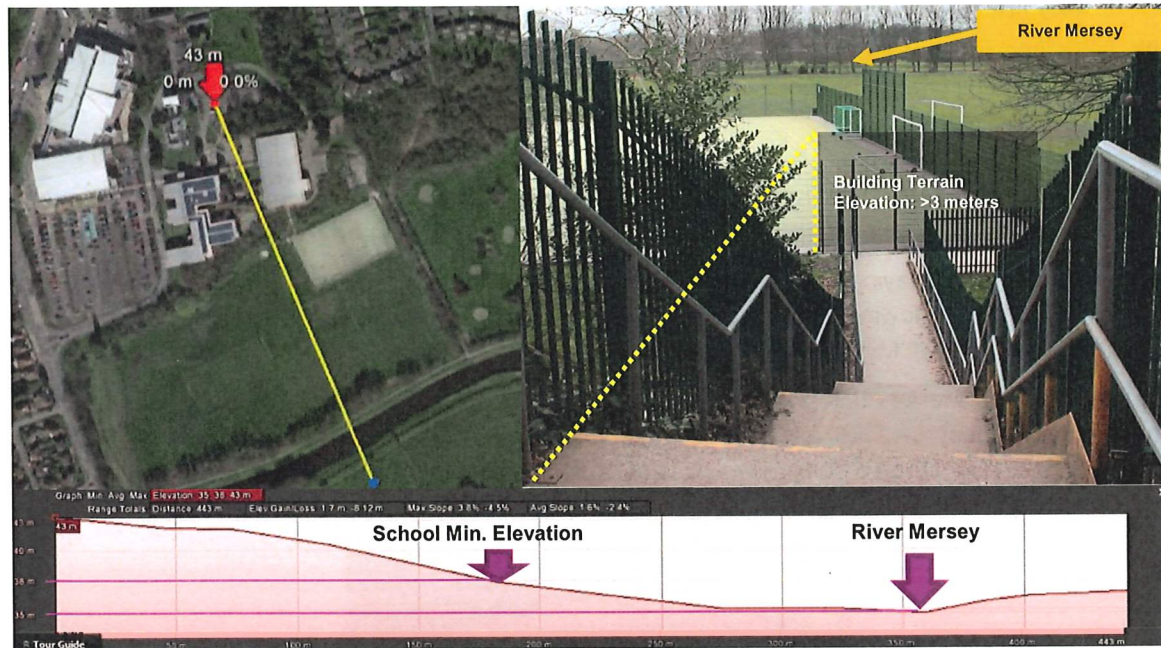


Figure 5 – School's Building area elevation profile (source: Google Earth and Willis Towers Watson)

It should be noted that the area south of the River Mersey is protected by flood defences with an estimated design return period of approximately 1 in 100 years. In addition, the eastern area of the northern embankment has been observed to be the least elevated (with lower spots sections) and in the past this caused flood waters to reach the sports grounds.

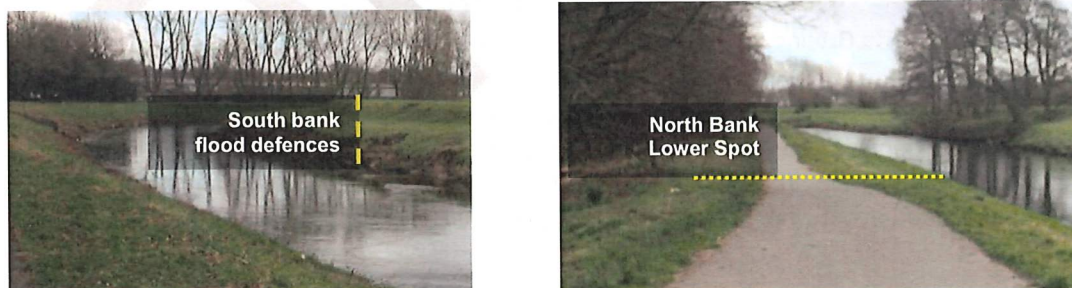


Figure 6 – River banks: southern flood defences elevation and northern bank lower spot



Figure 7 - Likely flood extent in the worst case scenario (not considering flood defences), overlaid with infrastructure network (source Willis Towers Watson and Environment Agency)



Figure 8 - Potential flood areas part of Parrs Wood High School (source Willis Towers Watson and Environment Agency)

Surface Water Flooding

There is also a risk of flash flooding, surface water run-off and accumulation. The elevation difference within school campus is significant and creates conditions for surface water run-off and potential localised flash floods accumulating in the low lying areas after a severe rainfall.

Surface water flooding was assessed comparing risk information and maps from sources such as JBA and Environment Agency. It can be seen in Figure 9 that localised surface water flooding with depths up to 300mm could occur in the vicinity of the main electrical area entrance. This level of flooding is associated with a return period of 1 in 30 years and higher water accumulation is possible in the north side of the campus within return period of 1 in 100 years to 1 in 1000 years. In this second case additional areas could be at risk:

- the basement area of the music block, where the boiler room is located;
- the lower ground area of the potting shed, where the greenhouse boiler is located.

It should also be noted that the Manchester City Level 2 Strategic Flood Risk Assessment classifies East Didsbury as a critical drainage area. Storm drains are located around the site, which will collect and convey flood waters away from the school's building area. It would be expected that this will reduce the peak water surface height on-site during a flood event.

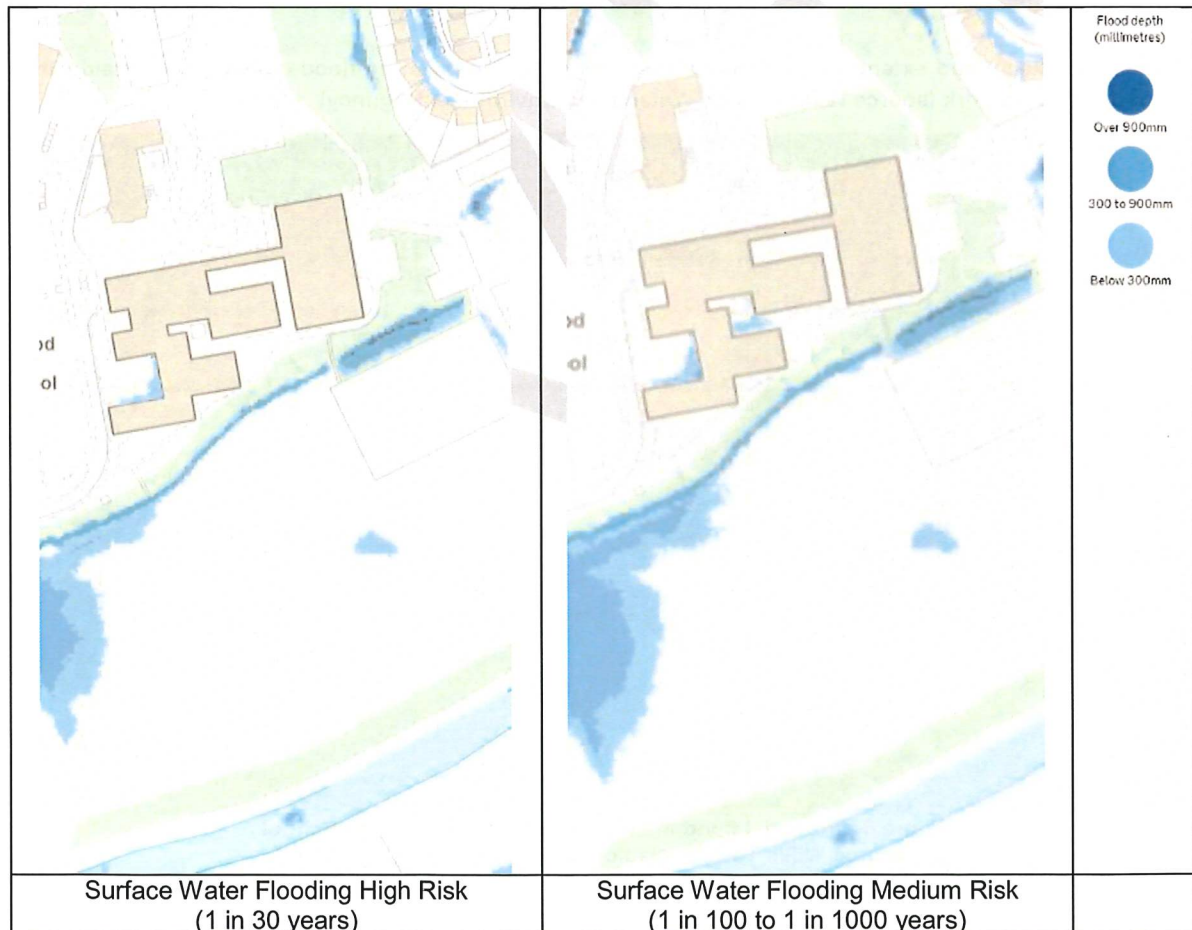


**Figure 9 - Potential surface water flooding areas
(source Environment Agency)**

The information in Figure 10 by JBA confirms the likely extent and risk associated with flash floods in the area. In terms of the potential water depths, these are indicated to be in the range of 300mm to 600mm. The return periods are slightly higher which indicates that occurrence of such depths is in the conservative likelihood ranges.

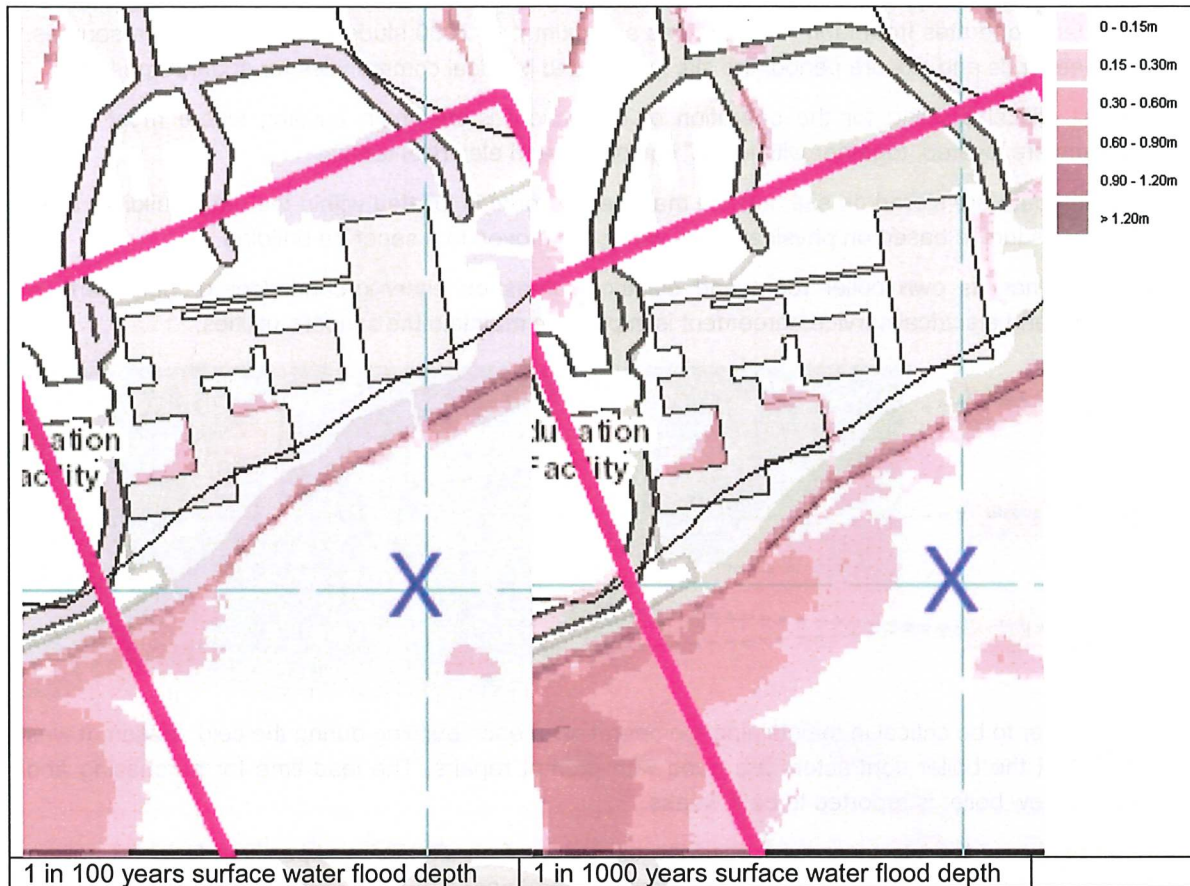


Figure 10 - Potential surface water flooding areas (source JBA)

Groundwater Flooding

There is a limited potential for groundwater flooding to basements at the site, due to the local terrain which could act as a collector of groundwater and raise the underground water table. Information by the British Geological Survey is presented in the figure below indicating the potential for such flooding. However, the academy team reported that for the most vulnerable areas no historical events have been observed in the recent past.



Figure 11 - Groundwater flooding potential (source: British Geological Survey)

Flood Vulnerability Considerations

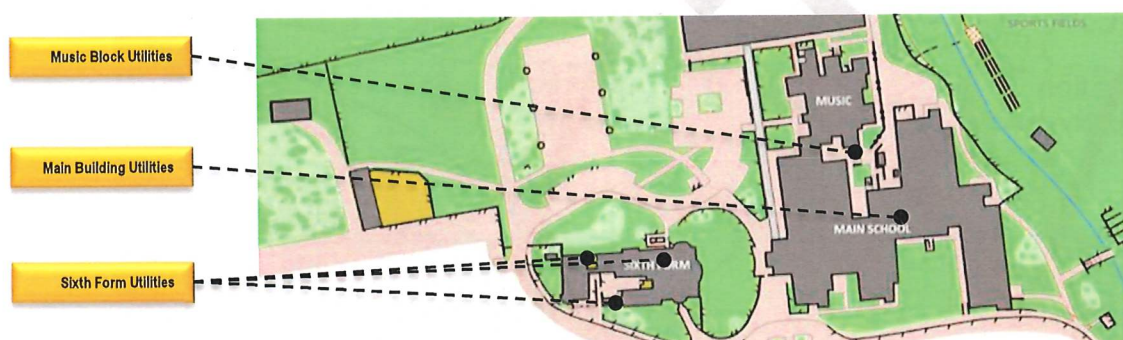
General considerations

The academy operates from Mon – Fri and has approximately 2000 students and 300 staff resources. During weekends and closure period, the site is operated by local communities for sport purposes.

The most critical building for the operation of the school is the main building where most of the classrooms are located, together with key IT equipment and electrical rooms.

Most of the data are stored on site and the main server room is located within the main building. Data backup procedure is based on physical tapes which are moved to a separate building.

Each block has its own boiler room and electrical areas on either ground floor or basement. A mechanical and electrical service agreement is in place to maintain the school's utilities.



Boilers appear to be critical in maintaining the operation in each building during the cold season. It was reported that the boiler contractors are good with prompt repairs. The lead-time for purchasing and installing a new boiler is reported to be 4 weeks.

During the survey the site team mentioned the existence of on-site spare capacity in terms of boilers (the machinery is not 100% saturated during normal operations).

Due to the nature of the flood hazard on site, critical areas are considered to be the sport grounds - in particular riverine flood risk – and the main basements / utilities area. There are two main basements on site, one in the sixth form building and one in the music block. Both are used as boiler rooms / storage area / server rooms. The lower ground floor of the main school building hosts the main electrical rooms with PV inverters and medium voltage dry transformers.

A detail of each vulnerable area per building is reported below.

Sixth Form



Ground Floor – Key Areas:

- **Boiler Room:** A small boiler room is located at the ground floor of the building and contains a 1 x condensation boiler at the wall, raised, a 1 x pressure unit at wall (1.5 bar) together with electrical panels are also installed on the walls, generally elevated at least 30 cm from the floor. Housekeeping standards observed during the

	survey were generally low in this room. • <i>Information Technology Main Server Room:</i> the main IT server room is located on the ground floor. 1 x metal rack hosts the IT equipment and is positioned on a 15 cm elevated plinth. The roof of this room collapsed in the past due to the humidity and has been replaced. • <i>Air-Con Refrigerators</i> are located outside, elevated 40 cm from the ground. • <i>Electrical Room:</i> an electrical room is located at the ground floor, containing the 1.20m elevated from ground arrival points of 2 x 415 volts power lines connected to the school's electrical substation. Electrical power is then distributed from here to the building through 2 electrical panels 1.20 m elevated. Other obsolete and unused electrical equipment is stored in this room. • Parrs Wood Lane Substation No: 172032 (located in Parrs Wood House's Courtyard): this substation contains a 1MVA oil filled transformer, built in 1964, which feeds the house and satellite buildings
	Basement Level – Key Areas The building basement is accessible from the internal corridor and hosts general equipment storage, a hard copy paper archive, a small server room, and a boiler room. No openings such as windows or skylights were observed during the survey, while heating pipes are displaced at ceiling level. Paper files are stored in cardboard boxes piled on the ground. • The server room consists of a 1 x rack 15 cm elevated from the ground on its plinth and cooled down by an A/C fan. The server room is not provided with drainage system nor false ceiling / floor. • The boiler room burns natural gas through 2 x small condensation boilers, approximately 40 cm elevated from the ground. Electrical panels are also installed in the basement, generally elevated from the ground. Minor water pipe leakage was observed during the survey in this room.

Music Block



On the ground floor, the canteen includes an IT area with 10 desktop computers – generally, the hardware is elevated from the floor. A small electrical room is also located in the building.

Boiler Room: a boiler room is located in the basement with 3 main units, serving the music and the main building. This room is at a lower level but elevated when compared to the river.

Sports Hall



The sports hall is equipped with an event room (empty at the moment of the survey), a small dining room, and the main auditorium room.

Main School Building



Ground Floor – Key Areas: The library/learning room is equipped with 4 large tables, each equipped with 2 rows of 8 computers (total 64), generally elevated from the ground. The building's main server room is accessible from the library. Here the servers are installed on 2 metal racks, elevated approx. ~ 15cm from the floor and cooled down by an A/C fan.



First Floor – Key Areas: 5 computer rooms are located on this floor. This building is served by boilers located on higher floors which have not been inspected during the survey. Installed on the roof is a 250kW solar photovoltaic system.

Lower Ground Floor – Key Areas: The lower ground floor hosts the main electrical area, which is accessible only from the extern and includes:

- The main corridor, where 4 electrical panels are installed on the wall, elevated from the ground;

	• Parrs Wood Main School Substation No: 178495: this substation contains a 1MVA dry transformer, built in 1999 (Winder refurb) with SF6 vacuum switch (switchgear HV), which feeds the main school, the music block and the sports centre. • 1 x solar panel main electrical cabin and inverters (not elevated). LIFT NO (ADJES TEL REF. SOL. 2 BORR
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Other Buildings

- *Synergy Centre:* Information technology equipment is generally elevated. The Synergy Building is not provided with a basement and CCTV is installed outside. The entrance is approximate ~40 cm elevated compared to the terrain.
- *Potting Shed:* The boiler serves the greenhouse only and it is located in a lower position compared to the ground level. Housekeeping observed in the building was of low standard.
- *Memorial Garden* Electrical and information technology equipment are elevated from the ground, and heating is provided with an electric radiator.

Sports Grounds

	This area of the school is the most relevant in terms of flood loss history. Another parcel of land south of River Mersey is also owned by the school, and it is protected by the southern embankment which acts as a local flood defence. This area was not inspected during the survey.
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Loss Assessment

Property Damage and Business Interruption Values and Considerations

Property Damage Values

During the survey, the Parrs Wood High School management provided a valuation assessment developed in 2016 reporting a total value of GBP 41.290 million in respect of land value (6.615 million GBP) and building value (34.675 million GBP). A summary is shown in the table below (this valuation does not include contents).

Parrs Wood High School	Asset Values (GBP million)
Land Value	6.615
Buildings and Civil works	34.675
Total Values	41.290

A detailed breakdown of the contents value was not available at the time of the survey, thus to facilitate the evaluation of the Estimated Maximum Loss (EML), Willis Towers Watson have adopted a bottom-up approach, providing a range of estimated replacement values of key items expected to be affected by the loss scenario. **The Willis Towers Watson estimates are based on our knowledge of the site and equipment values from similar installations, but we strongly suggest Parrs Wood High School develop an estimation of the replacement values on site to support their risk management strategies.**

Business Interruption

A detailed business interruption calculation was not available at the time of the survey. It was reported by the management team that the annual funding consists in approximately ~ 11.5 million GBP.

Additional revenues are obtained by local communities which utilize the schools facilities for leisure and training activities. During the survey, these additional revenues were estimated by the site team in approximately 250,000 GBP / year.

Factors that contribute to overall business interruption period are discussed below.

Lead Times: The critical school items and equipment installed have anticipated replacement lead-times as follows:

- Boiler Rooms - 1 month
- Main Power Transformers - 3 months
- Air Conditioning Refrigerators - 1 month
- IT Server Room - 1 month
- Football Pitch - 2 months

Probable Maximum Loss (PML) Assessment

This section describes the Probable Maximum Loss (PML) assessment and underlying assumptions in detail.

Assumptions for PML Assessment

The Probable Maximum Loss (PML) term used within this report is defined as the largest loss potential from a single occurrence of the peril in question (flood), related to a specific return period. We see often clients choosing the 1 in 100 year return period as a benchmark to assess flood risk scenarios and this was also used in this assessment as a benchmark.

It is assumed that at the time of loss, the most critical protection or detection system is impaired and that only the passive protection features, such as spacing, compartmentation, construction, plus available private and public manual flood protection measures are considered effective.

PML scenarios are based upon realistic events and the best indication of the type of loss that can occur with assets of this type is obtained by a review of hazard, vulnerability and past losses.

In order to calculate the PD PMLs, the vulnerability of each building and critical asset has been assessed for the expected hazard intensities of each return period. From this assessment, a damage ratio has been estimated for each item expected to be affected by the event. These damage ratios are then aggregated to provide the estimated property damage for that return period.

The BI PMLs are assessed differently. Each piece of key equipment is assessed and if it is determined to be vulnerable for a given return period its downtime is estimated to calculate the expected BI impact.

PML Scenario

Scenario Description

The academy's experience and loss history indicate that flood events do occur. Based on the hazard and vulnerability assessments of this report, following a period of heavy rains we can consider two scenarios of correlated events:

- A. Riverine Flood:** the volume of water in the River Mersey could increase and flood waters could hit the sports ground at Parrs Wood High School. The main school's buildings are significantly elevated when compared to the expected flood depth, and there is little likelihood of flood propagating to other areas.



- B. Surface Water Flood:** a medium to low level of flooding risk exists at the school and flash flood waters could impact the Main Building Electrical Rooms: transformer rooms and PV system inverter room. Here, it should be noted that in a more remote scenario (1:100 to 1:1,000 year return period), also the Music Block – Main Boiler Room and the Potting Shed – Boiler Room could be considered at risk (ref: Local Hazard Assessment Section).



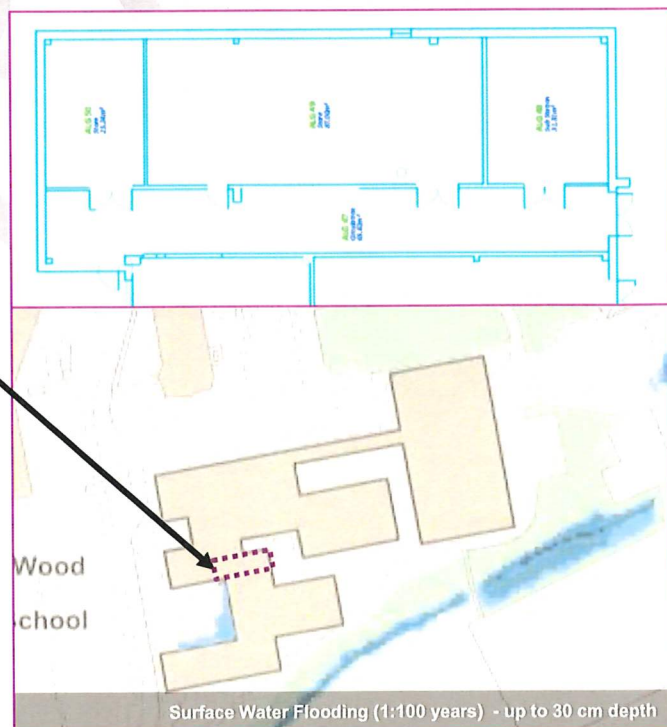
PV Inverter and Electrical Panel



Transformer Room Entrance



Main Electrical Room Entrance



Scenario Assumptions

The following assumptions have been made:

A. Riverine Flood:

1. The sports grounds would be flooded.
 - a. Excluding contamination issues - cleaning costs associated to this asset are estimated in the range of 20,000 GBP;
 - b. Sports grounds unavailability could range from 1 to 3 months whilst clean-up works are completed;
2. The all-weather football pitch would be also flooded and damaged.
 - a. Repair costs are estimated at 20,000 GBP, including electrical equipment replacement costs;
 - b. The field unavailability could range from 1 to 3 months;

B. Surface Water Flood:

1. Step-Down Transformer (50,000 GBP) and HV Switch Gear (15,000 GBP) affected, lead time 3 months.
 - a. During the site survey it was not possible to enter the transformer rooms and directly inspect the machinery. This scenario assumes electrical equipment not being elevated on plinths, exposed to the direct action of water.
2. PV System inverter affected – 80,000 GBP (assumed), lead time: 3 months
3. Business Interruption:
 - a. It should be noted that the building areas affected by the event could require 2 to 4 weeks to dry and be accessible;
 - b. With the main power transformer unavailable the entire school would be not provided with electrical energy and would be closed until the electrical items will be replaced.
 - c. An Emergency Diesel Generator under controlled measures could sustain the academy's electricity and power needs; this would have been sought through the academy's own Service Level provider, Energy Management Unit, Manchester City Council (MCC).

PML Estimate – 1 in 100 year return period

The Probable Maximum Loss based on a 1 in 100 year return period that could result from an event of this nature has been evaluated as follows:

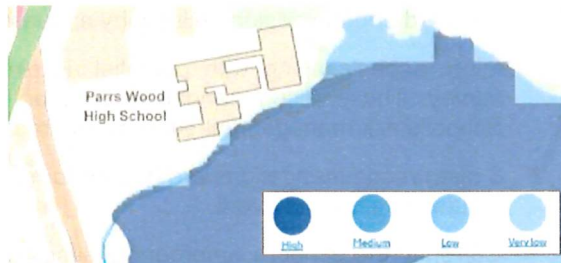
A. Riverine Flood - Sports Ground		Estimated Loss (GBP)
Property Damage Loss		40,000
• Sports Grounds Cleaning Costs		20,000
• All weather football pitch repairmen costs		20,000
Operations Estimated Downtime:		
• Sports Grounds unavailable		3 months
B. Surface Water Flood – Main Building Electrical Room		Estimated Loss (GBP)
Property Damage Loss		150,000
• Transformer and HV Switchgear		65,000
• 1 x solar power inverter and electrical panels		80,000
• Clean Up Costs		5,000
Operations Estimated Downtime:		
• Electrical power unavailable		3 months
Scenario Summary (Riverine Flood and Surface Water Flood)		PML (GBP)
Property Damage Loss (A and B)		190,000
Overall Estimated Downtime:		3 months

PML Estimate – 1 in 30 year return period

In order to provide the Department for Education with a wider understanding of the potential loss distribution, an additional Loss Scenario has been developed for a less severe return period. In particular, for a 1 in 30 year return period event, we would expect the following scenario:

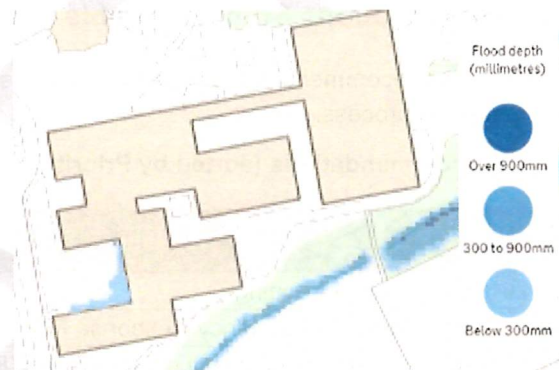
A. Riverine Flood:

1. The sports grounds would be likely flooded.
 - a. Direct Damage: 20,000 GBP;
 - b. Downtime: 1 to 3 months;
2. The all-weather football pitch would be also flooded and damaged.
 - a. Direct Damage: 20,000 GBP;
 - b. Downtime: 1 to 3 months;



B. Surface Water Flood:

1. The electrical room would likely be minimally affected by the event, being the surface water runoff of a minor entity and the room corridor wide enough to allow the water depth to decrease further.
 - a. Direct Damage: None;
 - b. Downtime: None;



A. Riverine Flood - Sports Ground		Estimated Loss (GBP)
Property Damage Loss		40,000
Operations Estimated Downtime:		3 months (only sports grounds)
B. Surface Water Flood – Main Building Electrical Room		Estimated Loss (GBP)
Property Damage Loss		Not Affected
Operations Estimated Downtime:		Not Affected
Scenario Summary (Riverine Flood and Surface Water Flood)		PML (GBP)
Property Damage Loss (A and B)		40,000
Overall Estimated Downtime:		3 months (only sports grounds)

Risk Mitigation

The main loss prevention findings are:

- Overall, the general status of the facilities at the time of the survey appeared visually of a high standard and the design philosophy appeared to be appropriate to the level of flood hazards.
- Minor aspects along with potential risk improvement actions have been identified from the survey. These recommendations can be used to improve and optimize Parrs Wood High School's risk management strategy and reduce the potential impact of a catastrophic event.
- 8 open recommendations are offered to mitigate the potential losses for the location following a natural catastrophe event.
- Currently the school's emergency response plan is not addressing flood hazard, and detailed suggestions have been summarized in order to further support Parrs Wood's catastrophic risk resilience management.

Recommendations Summary Table

The following recommendations have been proposed to assist Parrs Wood High School along with the risk mitigation process.

Flood Recommendations (sorted by Priority):

Rec. Number	Name	Priority	Complexity	Cost Benefit
FL 2018.01	Housekeeping	■■■■■	■□□□□	■■■■■
FL 2018.09	Flood Emergency Response Plan	■■■■■	■□□□□	■■■■■
FL 2018.02	Increase the Electrical Equipment Elevation	■■■□□	■■■□□	■■■■■
FL 2018.03	Increase the Boilers Elevation	■■■□□	■■■□□	■■■■■
FL 2018.04	Temporary Flood Protection Measures	■■■□□	■■■■■	■■■■■
FL 2018.08	Emergency Diesel Generator Agreement	■■■□□	■■■□□	■■■□□
FL 2018.05	Mobile Flood Protection Equipment	■■■□□	■■■■■	■■■□□
FL 2018.06	Water Drainage System	■□□□□	■□□□□	■■■□□
FL 2018.07	Astro football pitch flood protection design	■□□□□	■■■■■	■□□□□

Recommendations Criteria

To simplify the understanding and the evaluation of the suggested risk improvement actions, each recommendation is classified into the following categories: Priority, Complexity of Implementation and Cost-Benefit Ratio.

The key tables reported below explain in detail these 3 categories and their ranking meanings.

A. Recommendation Priority

Code	Name	Description
1	High Priority	These items address issues, which could have a critical impact on the asset risk profile, and immediate action is required.
2	Medium Priority	These items address issues which could have a significant impact on the asset risk profile. The site management should take this suggestion into consideration at the first occasion.
3	Low Priority	These items address issues which could have a moderate impact on the asset risk profile. The client management should plan the suggested implementation within the group multi-year strategy.

Table 1.1 – Recommendation Metrics: Priority

B. Complexity

Code	Name	Description
HE-PR	Human Element / Procedural	This recommendation type is mainly related to a change in the internal organizational procedures / employees behaviour.
Minor Implementation	Minor Maintenance / Installation required	This recommendation type requires a minor calibration or maintenance of existing assets / equipment.
Major Implementation	Major Maintenance / Installation required	This recommendation type may include a major review / improvement of the building, such as structural review / retrofitting.

Table 1.2 – Recommendation Metrics: Typology

C. Cost Benefit Ratio

Code	Name	Description
1	Limited Value for Money	High cost risk mitigation measures that will likely relate to low reduction of PML.
2	Average Value for Money	Modest cost risk mitigation measures that will likely relate to modest reduction of PML.
3	Good Value for Money	Low cost risk mitigation measures that will likely relate to significant reduction of PML.

Table 1.3 – Recommendation Metrics: Cost Benefit

Cost Effective Loss Prevention and Protection Recommendations

The following risk improvement recommendations were developed during this survey and the main findings were discussed at a closeout meeting with management. The recommendations proposed are based on observations made and discussions held with the various personnel met during the survey, and from the experience gained from actual losses within related industries.

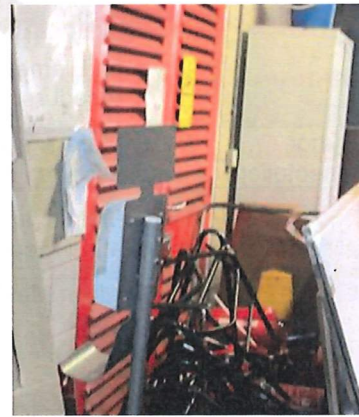
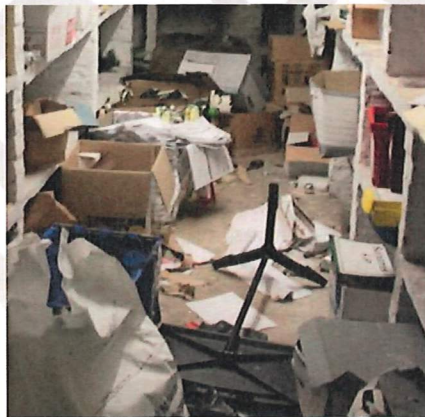
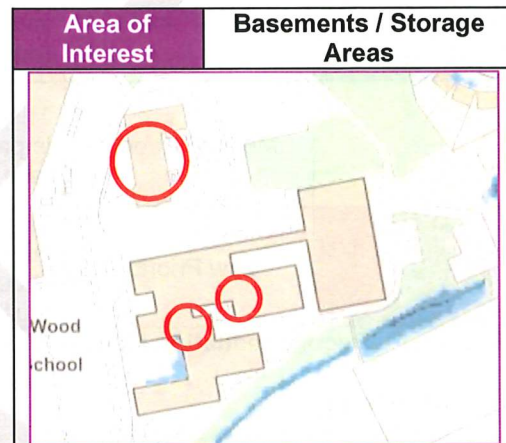
FL 2018.1 Housekeeping

Priority	Complexity	Cost Benefit
High	HE / PR	3
■■■■■	■□□□	■■■■■

Description:

During the survey, it was observed that most of the escape routes were blocked and /or not easily accessible due to a general low housekeeping standard. This was observed particularly in basements / utility areas.

It is important to keep key areas as tidy as possible in order to facilitate any eventual emergency operations and avoid loss amplification factors.



Proposed Recommendation:

We recommend that Parrs Wood considers including a self-inspection walk around of the key basements, storage areas and utility rooms in the routine maintenance procedure. This would allow an early identification of corrective actions and the site management to address any potential issue in a timely manner.

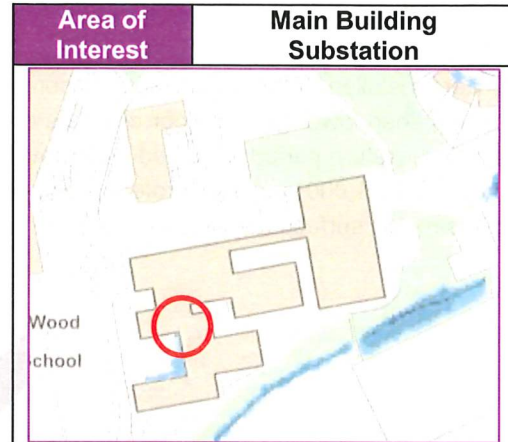
Estimated Cost for Implementation: No significant investments (mainly human element). Additional costs may be required to remove excess material from the site.

FL 2018.2 Increase the Electrical Equipment Elevation

Priority	Complexity	Cost Benefit
Medium	Minor Implementation	3
■■■■□□	■■■■□□	■■■■■

Description:

Transformers installed in the electrical areas could be elevated on plinths above the lower return period expected water level (30 – 90 cm at the 1 in 1,000 year) to protect the assets from a catastrophic surface flooding event.

**Proposed Recommendation:**

We recommend that Parrs Wood High School considers elevating the key electrical equipment on plinths in order to keep the assets at approximately 90 cm from the ground (above the estimated surface flood dept. at the 1 in 1,000 year return period).

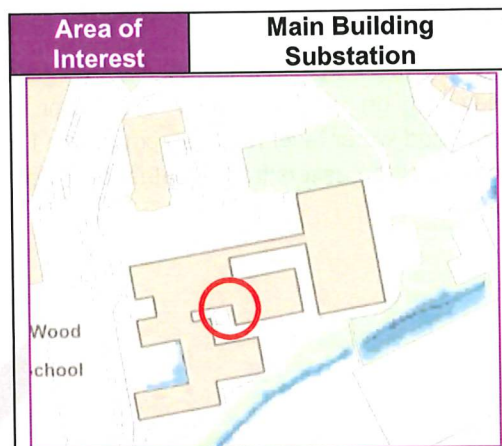
Estimated Cost for Implementation: Minor Implementation required [2,500 GBP ~ 5,000 GBP].

FL 2018.3 Increase the Boilers Elevation

Priority	Complexity	Cost Benefit
Medium	Minor Implementation	3
■■■■□□	■■■■□□	■■■■■

Description:

Boilers installed in the music block basement and in the potting shed lower ground floor could be elevated above the lower return period expected water level (30 – 90 cm at the 1 in 1,000 year) to protect these assets from a catastrophic surface flooding event.

**Proposed Recommendation:**

We recommend that Parrs Wood High School considers elevating these boilers in order to keep the assets at approximately 40-60 cm from the ground.

Estimated Cost for Implementation: Minor Implementation required [2,500 GBP ~ 5,000 GBP].