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The Whitworth

Art Gallery Roof & Gutter Remedial Works

MEP Stage 3 Report

Prepared for University of Manchester
July 2024

High-performing partnership
Higher performing buildings

PROJECT

UoM, The Whitworth – Art Gallery Roof & Gutter Remedial Works

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Nabeel Mohamed

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01		Update to reflect team discussions	Sept 2024	Brian Doran	Asitha Bandaranayake
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Company	University of Manchester
Name	Stuart Lockwood
Role	
Date	
Signature	

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Name	
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1.0 Executive Summary

TB+A have been appointed by the University, as part of the project team, to develop solutions to water-ingress problems in specific areas of the roofs at the Whitworth Art Gallery.

The purpose of this project is to address current rainwater problems which appear to be due to rainwater intensities exceeding the capability of the existing rainwater "goods". The roof gutters illustrated adjacent, have experienced the main problems.

TB+A have assessed the existing rainwater goods and concluded that they have insufficient capacity, in relation to current standards and current/future rain intensities.

Design development from the appointed building surveying team (SDA) and TB+A have proposed a scheme to divert some existing roof runoff, away from these valley gutters. This will, in turn, reduce the flow to the gutter outlets, significantly reduce the risk of flooding and protect the heritage asset & building-contents.

The proposed works, therefore, include;

1. Roof of the main wing (above the Grand Hall) to discharge to the north and south elevations respectively
2. New eaves gutters to directly collect water from the roof-lights above the North and South Galleries to discharge directly to drain.

This remedial work reduces the roof area, discharging to each valley gutter (effect catchment area) from approximately 400m^2 to approx 160m^2 (a 60% reduction)

The proposed routing, outlet and downpipe sizes are confirmed in this report.

Recommendations / Next steps

We propose the following actions at the commencement of the next stage.

i. Obtain feedback from the University on these proposals.
ii. Meeting with Manchester City Council - planners/listed building consent,
    a. Explain the necessity of the project, to address issues that are detrimental to the Listed building.
    b. Present our proposals for the long-term protection of the Gallery.
    c. Capture MCC recommendations
iii. Meeting with all Gallery, University and project team members to review the proposals and programme
iv. Specialist input to review roof access for ongoing maintenance

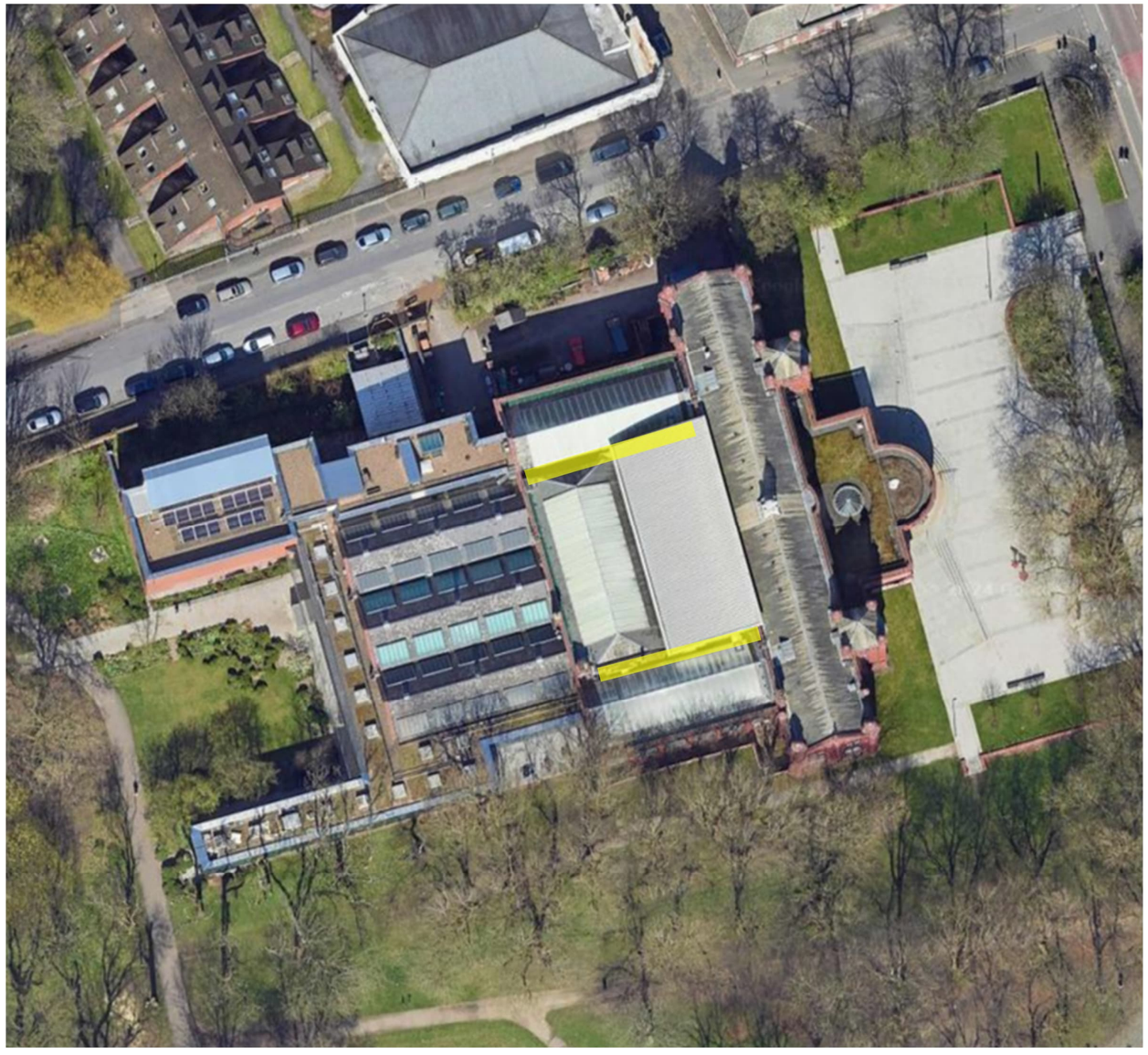


Figure 1 - Plan of Whitworth Art Gallery with location of problematic roof gutters highlighted.

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2.0 Introduction

Troup Bywaters + Anders (TBA) are appointed as part of the professional team to undertake the design of the roof and gutter modifications at the Gallery.

The client's plan, (to which we previously provided calculations) proposed to revise the roofs, including;

1. Divert surface water from the main pitched roof by adjusting the falls of the gutter towards the outlets located on the north and south elevation of the building.
2. Increase the size of the existing box gutter to the North and South gallery roofs;
3. Adjust falls to the infill roof to fall towards the north and south respectively so the burden is shared between two outlets.

Further revisions developed this to the solutions given in this report.

Scope of works

TB+A's scope does not include the carrying out of the roof redesign but includes the preparation of the calculations for the rainwater goods and associated roof catchment. Our work is in line with Historic England guidelines and British Standards. Our role therefore includes

- Scheme Design
  - Visit site to review the existing areas in question and review record information
  - Discuss with the client-team regarding concerns and previous problems arising
  - Carry out calculations on the roof rainwater in line with BS EN 12056-3:2000 assessing existing systems and proposed solutions
  - Where a roof rainwater "fail-safe" design cannot be provided, clarify the design criteria to inform the client on the limitations of their system.
- Detailed Design
  - Develop a Design Report, including sketch details for inclusion in the tender documents

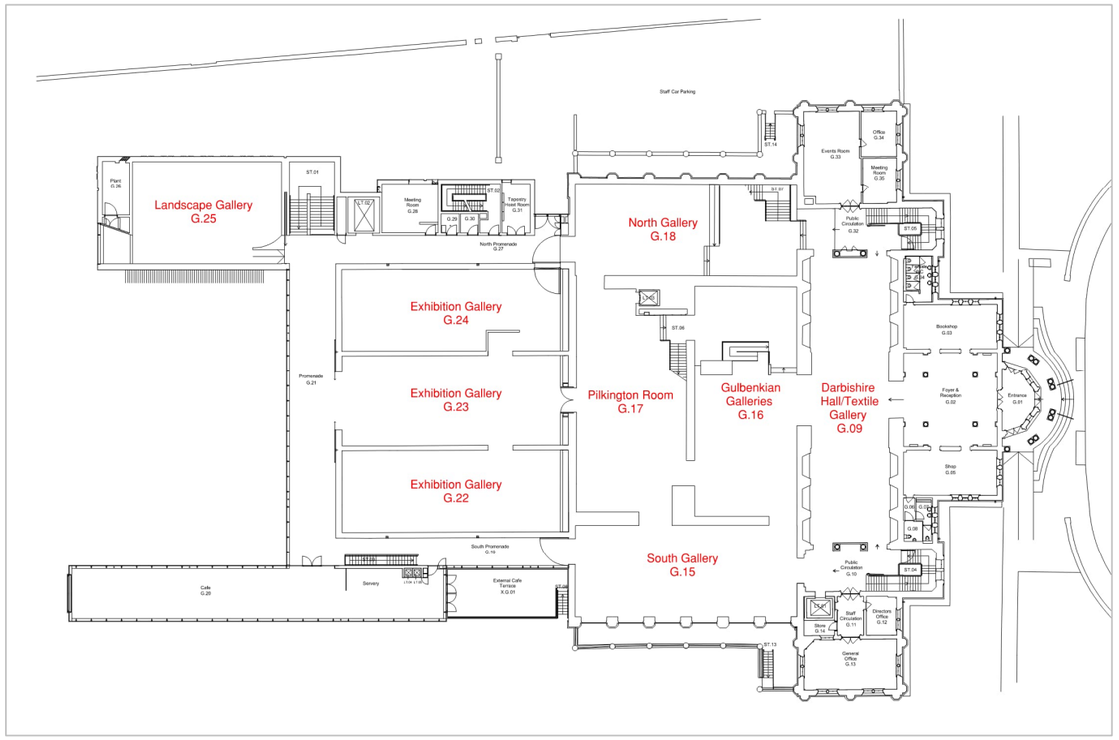


Figure 2 - Whitworth Art Gallery, Ground Floor Plan indicating primary gallery spaces

3.0 Modification of rainwater goods in building of historic significance.

From commencement of the design, the key drivers of this project have included.

1. Currently, periods of high rainfall cause water ingress into the building, which is damaging interiors and a potential risk to artifacts within the gallery spaces.
2. Water ingress can jeopardise the control of stable internal conditions within the gallery spaces.
3. An intensive regime of inspections and maintenance is carried out on the roof outlets to ensure no blockages occur, but this cannot mitigate against stormwater conditions.
4. The building is a significant heritage asset, with Listed status and, accordingly, any proposed works must be in line with conservation principles[1].

Assessing existing services, their condition and suitability.

As described in section 4 of this report, we have reviewed the existing rainwater goods. Our assessment of the existing installation is in line with industry and Historic England guidance[2] (using rainwater calculation methods as recommended in that guidance). This has identified a number of weaknesses in the existing system, including

i. Large areas of roof, draining to valley gutters, each with single outlets

ii. Outlets & downpipes from valley gutters, which are concealed within the existing building structure and therefore their size and performance cannot be assessed easily.

iii. Valley gutters with no opportunity to introduce "fail-safe".

iv. Existing downpipes and hoppers that are of inadequate size, when evaluated against current codes (ie BS 12056-3).

v. Condition of existing downpipes is poor, in certain areas

Section 6 describes the principles of the proposed works to address current problems. However, in developing the solutions, we have considered how best to retain the existing, if appropriate to the historic significance of the building.

Some of the existing rainwater goods are PVC and in the areas relevant to this project, these would be replaced with cast-iron (eg https://www.pambuilding.co.uk/products/classical-rainwater or alternative agreed products). The exact product selection will be determined at the next stage in agreement with the conservation officer.

We have also assessed if existing rainwater downpipes can be retained and supplemented with additional. In our view, the more sympathetic approach is to relace the existing, with the appropriately sized new goods; (the alternative approach of adding supplementary downpipes, to the existing, would require the installation of new parapet penetrations for new hoppers that would be, aesthetically and structurally, intrusive, compared to increasing the size of the existing).

Justification for the works

The works would therefore involve the alteration, replacement and addition of visible cast-iron rainwater goods to the building which, are demonstrably necessary to provide a sustainable solution for the Gallery, ie;

a. there is no reasonably practicable alternative to the works without harm; the existing situation is causing building damage & risks the building contents; the new system, to current standards, requires larger rainwater goods in line with current standards.

b. The impact and intrusion to the existing Listed building-fabric & services will be reduced to the minimum, through:
    i. Replacing existing plastic materials with cast-iron.
    ii. Using agreed heritage, cast-iron materials for new downpipes.
    iii. Developing solution for routing of downpipes, agreed with conservation team.

c. There is a clear anticipated public benefit through:
    i. Protecting the building-asset of The Whitworth
    ii. Providing significant improvements to the internal environment of the galleries, including protection of finishes and internal climatic control
    iii. Addresses environmental sustainability in relation to climate change and stormwater.
    iv. Larger downpipes will provide a more robust maintenance solution – eg reduced risk of blockages from larger pipe sizes.

Climate Change Adaptation.

Climate change adaptation has been reviewed by TB+A within the design, to consider associated aspects of the building's resilience. As illustrated below rainfall predictions identify the likelihood of wetter winters as well as higher stormwater intensities. Rainwater systems within the proposed works take cognisance of predicted rainwater requirements to mitigate against stormwater rainfall.

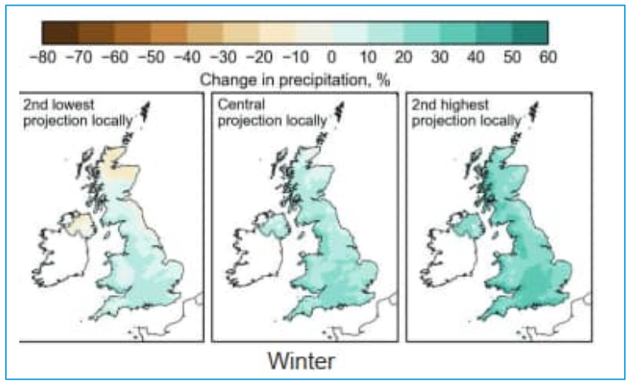


Figure 3 UKCIP Estimated future rainfall variances

[1] We reference: Historic England, *Conservation Principles, Policies and Guidance*; 1st April 2015; Conservation Principles, Policies and Guidance (historicengland.org.uk)

[2] Historic England; *Upgrades or Alterations to Rainwater Goods;* 23 July 2024; https://cms.historicengland.org.uk/advice/technical-advice/retrofit-and-energy-efficiency-in-historic-buildings/resilient-rainwater-systems/upgrades-or-alterations-to-rainwater-goods/

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Architectural and historic interest

The project will retain/respect the historic design and aesthetic of the building, and the final detailing of the new systems will be carefully detailed, mindful of the original rainwater solutions. Specific points that we will focus on, include (but not necessarily limited to)

i. Routing of new/replacement pipework to suit existing downpipe routes, which are, in main instances, recessed into the building fabric



Figure 4 - New downpipes to replace existing plastic and coordinate with existing rainwater pipe routes designed into the decorative finishes.

ii. Construction of enlarged openings to suit new hoppers, to handle required rainwater flows. Hoppers and associated weirs/spitters need to be enlarged with details agreed.



Figure 5 - New hoppers to replace existing (thereby providing suitable rainwater capacity) to be carefully detailed within constraints of existing building brickwork.

iii. Installation of new downpipe routes to avoid the risks associated with cascading rainwater from one gutter to another. As described in section 6, we propose new downpipe routes to avoid cascading.



Figure 6 – The images show the instance where rainwater downpipes "cascade" - discharging from an upper roof to a gutter on a lower roof. We would like to try to avoid this because (a) it increases the load on the lower roof, thereby requiring that lower roof to be provided with new (enlarged) outlets and (b) it increases the risk to the lower roof. As discussed in section 6 downpipes to ground may be taken from the upper roofs.

4.0 Existing Roof

The roof plan, below, illustrates our understanding of the how the roof drains to the respective valley gutters over the North and South Galleries.

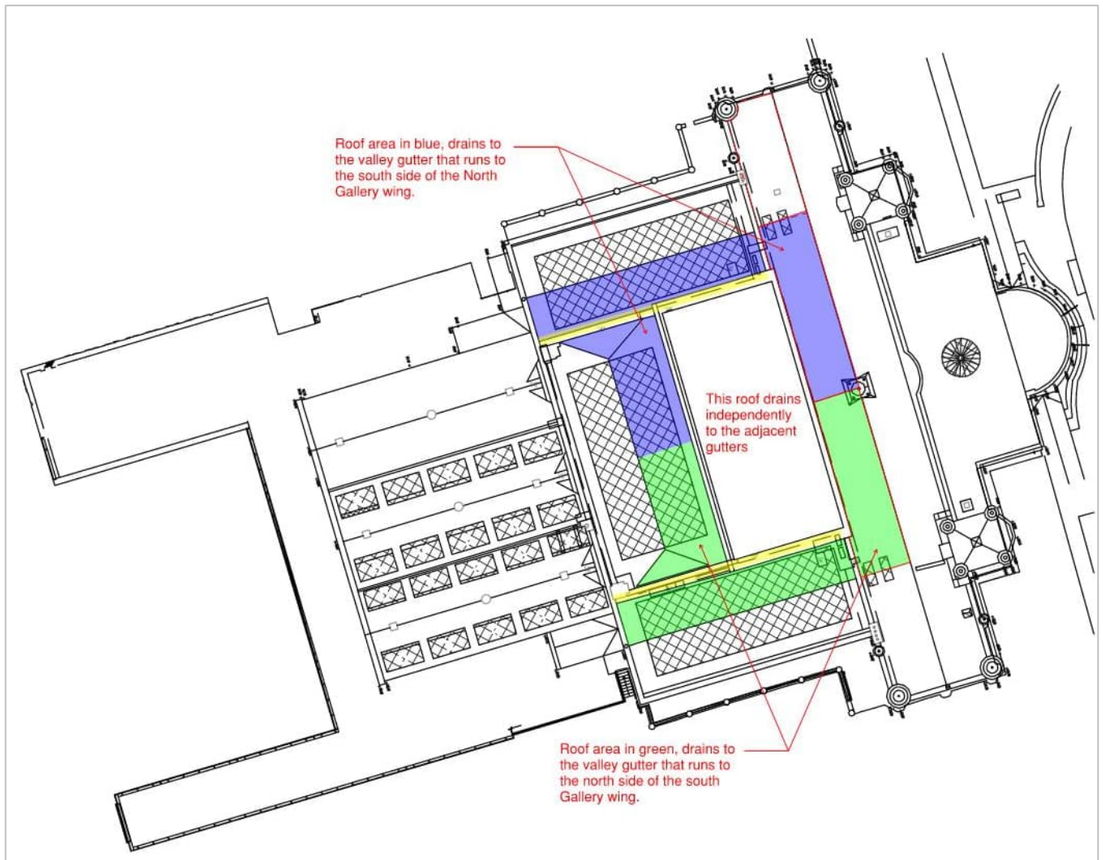


Figure 7 Roof plan indicating existing roofs that drain to valley gutters

i. Valley Gutters above North and South Galleries.

The lead-formed valley gutters above these Galleries each contain one rainwater outlet. As these outlets/downpipes are concealed, its capacity is not definable.

As illustrated adjacent, the valley gutters each collect the rainwater runoff from surrounding pitched roofs, with each valley collecting water from an *effect catchment area* of approximately 400m^2 (see appendices for calculation of catchment area).

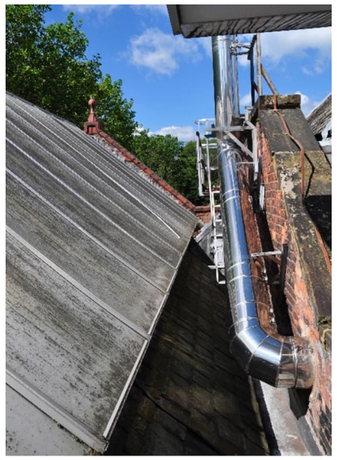


Figure 8 - Valley Gutter above South Gallery (looking west)

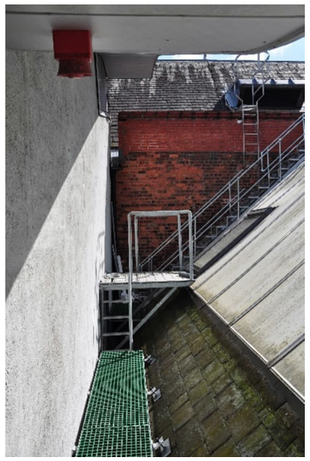


Figure 9- Valley Gutter above South Gallery (looking east)

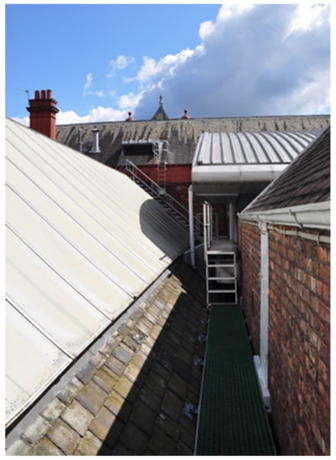


Figure 10- Valley Gutter above North Gallery (looking west)

ii. Main Roof (above Grand Hall)

The westerly side of the Main Roof drains to a lead parapet-gutter that currently falls to 4No outlets, two of which discharge to the valley gutters respectively.

The northern and southern portions of this roof discharge to the parapet gutters over the North and South Galleries respectively and then to an adjacent downpipe to ground level

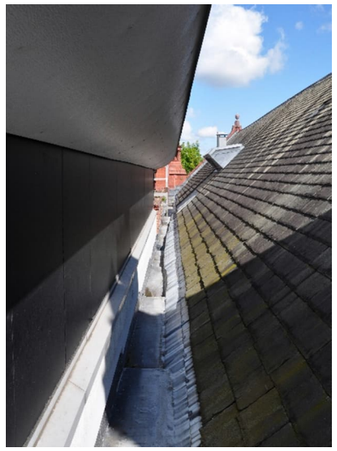


Figure 11 - Parapet gutter on south side of main roof (above Grand Hall), looking north

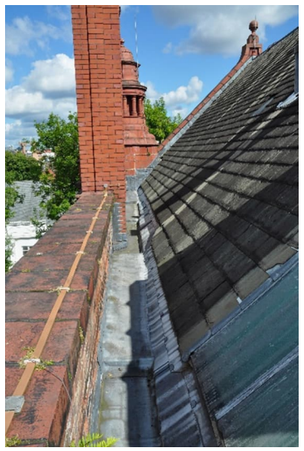


Figure 12 - Parapet gutter on south side of main roof (above Grand Hall), north end

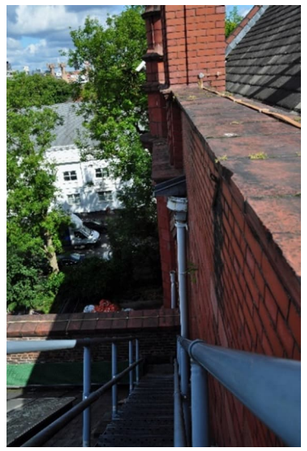


Figure 13 – RWO hopper from parapet gutter on south side of main roof, north end. This hopper discharges to the parapet gutter on the north side of the Northern Gallery roof which in turn discharges directly to its own hopper and downpipe (see fig)

iii. Roofs over the North and South Galleries.

These roofs consist of polycarbonate roof-lights that follow the pitch of their supporting slate roof. The valley gutters therefore collect runoff from the adjacent half of each of these roofs

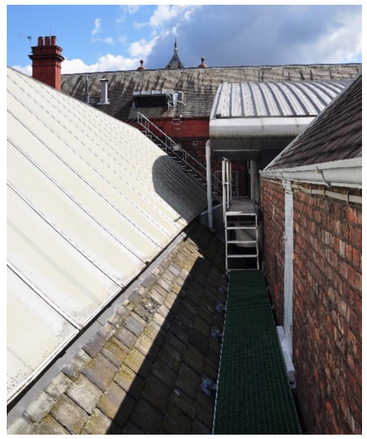


Figure 14 - North Gallery roof draining to valley gutter



Figure 15 - Detail of polycarbonate roof-light build-up on North and South Gallery roofs

The access to the valley gutters above both North and South Galleries is complicated by duct penetrations and housings, which allow ductwork to be routed to the galleries below.

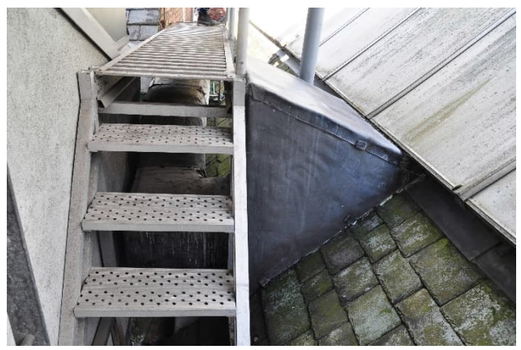


Figure 16 - Housing in Valley Gutter over North Gallery



Figure 17 - Housing in Valley Gutter over South Gallery

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5.0 Basis of Rainwater Design Calculations,

The following confirms the methodology followed in calculating the design rainwater runoff that the roof rainwater system may need to deal with, and notional risk associated with that design flow rate being exceeded.

The method of calculation is in line with Building Regulations Approved Document H[3] and follows the requirements of BSEN 12056-3[4].

i. Risk Factor.

The calculation procedures given within the British Standard recognise the relative consequences of the rainwater conveyancing system being overwhelmed in a storm condition and have recommended a "risk factor" multiplier based on the type of gutter and building type.

BSEN 12056-3 provides the following guidance for risk factors associated with the design of the roof. The risk factor is a multiplier of rainfalls intensity to calculate the system duty.

Table 1 - Risk Factors for Type of Roof Design

Gutter Type	Risk Factor
Eaves Gutters	1
Eaves Gutters where overflow would cause nuisance	1.5
Non Eaves Gutters with No safe overspill	2
Non Eaves Gutters in building with need for exceptional Protection	3

Within Annex NB, of the British Standard these risk factors are reinterpreted into building categories, ie

For calculating UK design flow rates, four categories of the building are given.

- *Category 1, A return period (T) of 1 year, minimum, used for eaves gutters and flat roofs.*
- *Category 2, For valley and parapet gutters, a return period, T, 1.5 x $L_{y\ (ref5)}$*
- *Category 3, For a higher degree of security (than category 2), a return period, T, 4.5 x L_y*
- *Category 4, For highest degree of security ($P_{r\ (Ref6)}$ approaching 0)*

These building-category recommendations, along with building anticipated life and storm return period, provide the basis of assessing the design storm-water flow rate.

ii. Area of roof assessed in calculations

The basis of the rainwater calculations is as BSEN12056-3 taking into account the roof geometry.

In line with Annex C of the British Standard, (*effective catchment area*) the allowance for wind-driven rain at an angle (NB.3.2 of BSEN 12056-3) is included. (See appendices for methodology calculating roof areas).

iii. Formula used for roof design.

From the British Standard, the basic formula for calculating the rainwater intensity is given as;

$$Q=rAC$$

Where:

Q = flow Rate (l/s); R = rainfall intensity (l/s/m^2); A = Roof Area (m^2); C = Runoff coefficient

The run-off coefficient is taken as 1 for the purposes of these calculations.

iv. Rainfall intensity.

In calculating to rainfall intensity the following has therefore been taken

1. Storm Water Concentration: Taken as 2 minutes in line with the Standard's typical value
2. Design Rate Category: In line with Annex (National Annex NB) we have treated The Whitworth as Category 3, as it has parapet gutters, and requires a high level of protection (as noted above).
3. Assumed life of building = 100 years

This category recommends that a storm return period of 4.5 times the life of the building, be utilised, ie 4.5 x 100 = 450years

Rainfall intensity for Manchester, (using formula in section NB.2.2 of BSEN12056-3):

- From Figure NB.3 the rainfall intensity, for a 2min storm event with a return period of 50years = **0.044** l/s/m2.
- From Figure NB.4 the rainfall intensity, for a 2min storm event with a return period of 500years = **0.064** l/s/m^2.
- From table NB.5, it can be seen that the maximum probably rainfall is given as = **0.152** l/s/m^2.

From the above, the rainfall intensity taken forward in the calculations is **0.064 l/s/m^2**.

[3] Building Regulations Approved Document H, *Drainage and waste disposal*; 2015 Edition (for England).

[4] BS EN 12056-3:2000; *Gravity drainage systems inside buildings - Part 3: Roof drainage, layout and calculation* (incl amendment no. 1)

[5] L_y: anticipated life of the building or period for which the contents need to be protected, in years.

[6] P_r: probability of exceeding the chosen rate of rainfall during lifetime of the building.

This intensity is the statistical meteorological rainfall value. The BS notes that it is not a value that includes a safety margin to accommodate other variances such as climate change, failure of outlets etc.

However, this intensity, giving a *"higher degree of security"* acknowledges the value of the building and contents by making accommodation for severe storm occurrence.

v. Downpipe design

Based on table 8 in BSEN 12056–3, the maximum capacity of a 150mm (internal diameter, ID) RWP would be **31.6 l/s** (at 0.33 filling factor as given in BS).

Similarly, a 200mm and 100mm (ID) pipe would have a capacity of around **68** and **10.7** l/s respectively.

A 75mm ID downpipe would have a capacity of **5** l/s.

We understand that some existing downpipes may be 75mm. Irrespective of flow rates, unless serving a limited roof area with external eaves, we would recommend that downpipes <100mm are not used due to the risk of blockages, from debris or foliage.

6.0 Design Proposals

Figure 25 illustrates the proposed work to the existing system which include

i. Gutter on western side of Main Roof (over Gand Hall) to be altered such that all rainwater discharge to the north and south ends of that gutter respectively.
ii. Provide a gutter to polycarbonate rooflight on the southern side of the North Gallery roof, to discharge to drain.
iii. Provide a gutter to polycarbonate rooflight on the northern side of the South Gallery roof, to discharge to drain.
iv. Provide leaf guards and the like to the retained valley gutters.

i. Main Roof (over Gand Hall)

The falls to the gutter to the western side of this roof are to be readdressed such that all rainwater discharges, to the north / south ends of that gutter respectively. The total catchment area of this roof (eastern elevation) is approx 466m^2, giving a total design flow rate of approx 30 l/s

Design flow from each spitter / hopper outlet at the north & south ends of the roof would therefore be (30 / 2 =) **15 l/s.**

The existing rainwater outlets and downpipes need to be amended to suit the new outlet design flow rates. We trust that the proposed falls can be accommodated within the existing gutters.

BS 12056-3 provides calculation methodology to estimate the required size of the outlet that can accommodate the design flow. Based on the design duty (15 l/s) the calculated size of weir outlets[7], that discharge into the hoppers, from the gutters, should at least 360mm wide, assuming a 100mm head of water in the gutter. The rainwater downpipe required to cater for this water flow-rate is 150mm

ii. Parapet gutters over North and South Galleries

As annotated in Fig 18 and 19, the existing outlets from the Main Roof (over the Grand Hall) discharge to the parapet gutters of the roofs below and we recommend that the water from the Main Roof be conveyed directly to drain via new downpipes.

If the water from the Main Roof was to be diverted to the North and South Gallery parapet gutters (rather than being routed directly to drain), the outlets from the parapet gutters will need to be assessed to ensure that they can accommodate the flow of both roofs (ie 15 l/s from the Main Roof and 4.7 l/s from the Gallery roofs). From our initial assessment, they would need to be enlarged).

The design flow from each spitter / hopper outlet at the North & South Gallery parapet gutters is assessed as 4.7 l/s (as existing); they will need modification if a greater flow is directed to them.

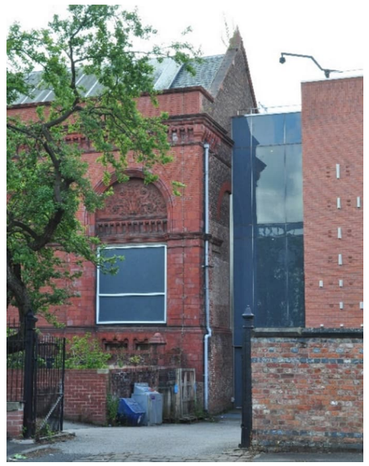


Figure 18 - Hopper & down pipe that conveys water north-west end of the North Gallery parapet gutter.



Figure 19 - Hopper & down pipe that conveys water south-west end of the South Gallery parapet gutter.

iii. Polycarbonate rooflights on North and South Galleries

To divert as much water as possible, away from the valley gutters, it is proposed that dedicated eaves gutters be installed to the rooflights so that their outflow can then be directly discharged to drain. The design flowrate from each rooflight to the valley gutter, is calculated at 6.47 l/s. The new eaves gutters should be selected, accordingly; we have examined some deep-flow gutters (as below) that may accommodate this flow (subject to detailed design).

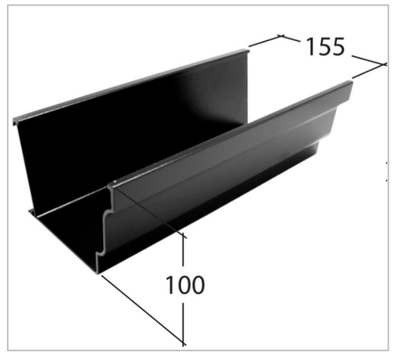


Figure 20 - Deepflow gutter, as Alutec Aligator Ogee No. 46

Neither of the two rooflights, offer an unrestricted path for the eaves gutters, due to the duct penetrations and housings, to the galleries below (fig 16 and 17 above).

Therefore, bespoke guttering may need to be fabricated in these locations. The outlets to these gutters will utilise at least 100mm downpipes discharging directly to drain.

[7] BA12056-3 highlights the difficulty of calculating outlet capacities and recommends the use of testing gutter outlets.

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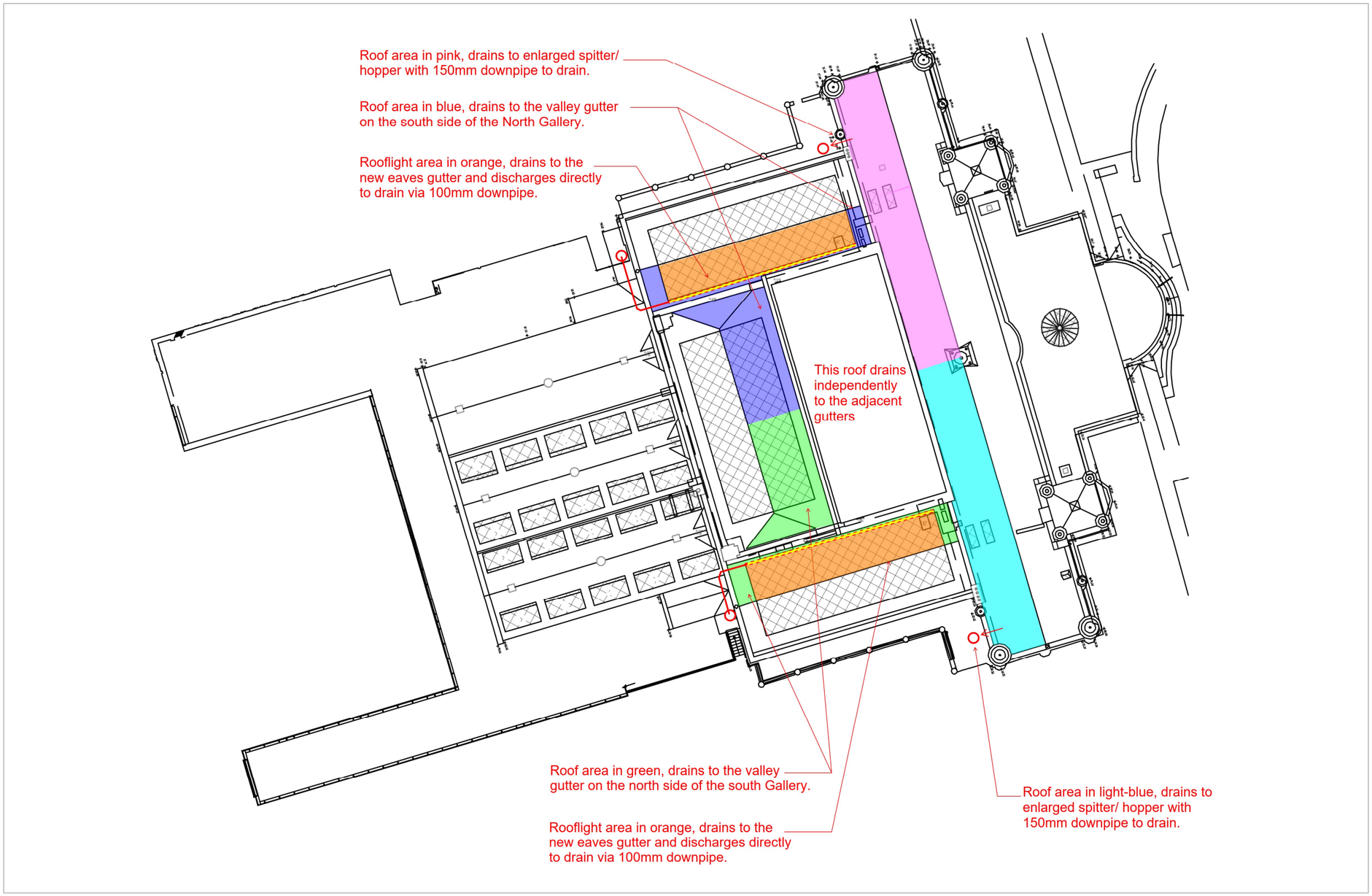


Figure 21 - Proposed Roof Works.

7.0 Project Issues

7.1 Programming and Phasing of the works

The works would be carried out to suit the Gallery requirement sand programme.

We assume the access to the roof works would be primarily from the staff car-park to the north of the north Gallery.

The proposed roof works could be carried out a a number of discrete tasks, eg

i. New eaves gutter to North Gallery rooflights, discharging to drain.
ii. New eaves gutter to South Gallery rooflights, discharging to drain.
iii. Upgrade north hopper and downpipes to Main Roof to accommodate new falls from Main Roof
iv. Upgrade south hopper and downpipes to Main Roof to accommodate new falls to Main Roof
v. Main Roof relay lead parapet gutter.

7.2 Health & Safety Risks

Please refer to residual risk register in appendices.

7.3 Project Risks

The following table summarises the main items that we have noted from survey visits, and that will need some consideration by the wider design team, cost consultant and University:

Table 2 – Whitworth Proposed Roof works SWOT review

Issue	Action		Issue	Action
Strengths			Weaknesses	
Proposed works provide significant (60%) reduction to the water flowrates imposed on the blind valley gutters.			Existing valleys remain and each served by one outlet.	Exact nature of problems experienced to date, could be reviewed further to consider mitigating measures.
Works will provide reduced risk and maintenance demands.	To review at Stage 4		Existing internal downpipes, built into building-fabric, remain.	Warning pipes that would warn of blocked drains could be considered.
Opportunities			Threats	
Other roof and rainwater problems may be considered to address at the same time.	To be reviewed with Gallery and UoM		Capacity of existing rainwater outlets and downpipes cannot be guaranteed.	Testing of existing to be considered.
Drainage design proposals will be completed in compliance with Approved Document H (Drainage and waste disposal, 2015), and in line with BSEN 12056-3 and at least achieving betterment to the existing installation.			Project goals and aims to be clearly reviewed.	Formal project workshop with all parties to be arranged.
			Building Regulations approvals – getting approvals on time.	UoM must appoint approved inspector for the proposed works.
			Planning and Listed Building Consent approvals needed.	Meeting with planners as part of UoM surgeries to be arranged as soon as possible. UoM to ensure that architect is appointed to progress these approvals (not within TB+As scope

8.0 Access & Maintenance

8.1 General requirements for access to plant.

An aim of the works is to improve the resilience of the rainwater systems and thereby reduce the maintenance demands on the roof.

In considering our design the following primary documents were considered.

Documents for Health and Safety.

- HSE: The Work at Height Regulations 2005, A brief guide, INDG401 (04/05)
- HSE: Working on Roofs, INDG284 (reprinted 4/04).
- BS 8437:2005: Code of practice for selection, use and maintenance of personal fall protection systems and equipment for use in the workplace.
- Construction Industry Publications: Construction Health and Safety Manual Section 7: Work at Height, 1996 (incorporating Dec 00, Dec 01, Jan 03, Jun 04 and Dec 04 amendments).
- Defence Works Functional Standard, Design & Maintenance Guide 08: *Space requirements for plant access operation and maintenance.*

Documents for Plant Maintenance.

- Design guide to maintainable buildings', outlined in Appendix 2 A1 of CIBSE guide to ownership, operation, and maintenance of building services, have been addressed.
- ISO 15686 Buildings and constructed assets – Service life planning

University Documents

The MEP services design has been carried out to comply with university procedures that include (but not necessarily limited to) the following, that are specifically relevant to services and their maintenance:

- PM PM7 - Code of Practice for Design Teams.

8.2 Access to roof areas.

Access-ways are provided at present and may provide reasonable access for inspection and maintenance at present. Some of these accessways have been modified since their original design and installation.

Given the extent of the works, we would recommend that all accessways be reviewed as a complete exercise, by a access/safety specialist to recommend the improvements that may be implemented to assist the Gallery in their ongoing maintenance works.

8.3 Access to roof voids.

Depending on agreed routes of new rainwater down pipes, access to roof voids may be required. We have not, to date inspected these voids, to propose suitable access routes.

8.4 Access towers etc, during construction.

Scaffold towers will be required to provide access to the roof and the installation of new down-pipes etc. These towers required for short periods or the duration of the contract will be agreed to avoid access and means of escape to/from the building.

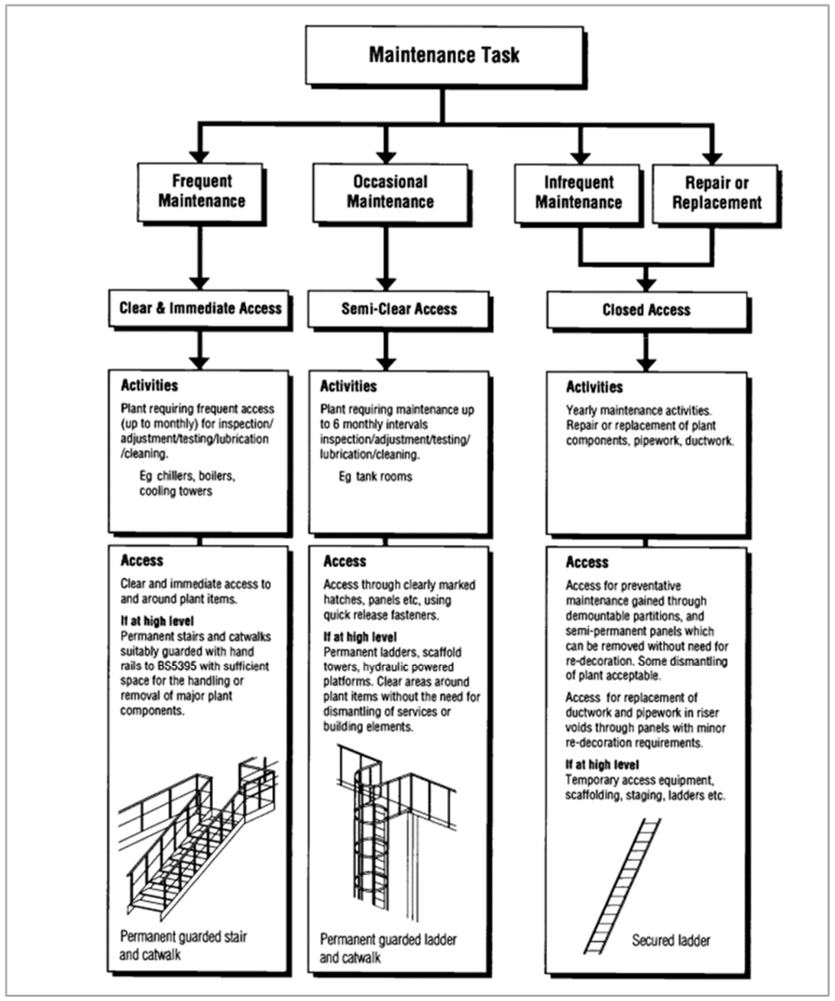


Figure 22 - Stair Access guidelines. Extract from Defence Works Functional Standard, Design & Maintenance Guide 08: Space requirements for plant access operation and maintenance.

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Appendices

Appendix 1-Standard Limitations for Building Reviews

1. Scope of inspection

Troup Bywaters + Anders LLP (TB+A) is not responsible for and shall have no liability as a result of or in connection with any events occurring after preparing the report and/or any other matters of which TB+A was not aware when preparing the report.

All comments relating to the condition of the building services are made on a purely visual inspection of visible and readily accessible parts of the system/building, without any destructive or exploratory investigations.

Accessible voids in the property e.g. riser ducts, floor voids and suspended ceilings, etc., can only be inspected at random and where practical without disturbing building occupants.

Identification or Inspection of asbestos or deleterious materials are excluded and we would recommend a specialist is engaged to obtain assurance in this respect.

All building fabric and structural form of the property is outside the scope of our expertise and inspection.

Any comments within the report with regard to compliance of the Building Services with current and statutory legislation, is to be taken as a guide and is based on the inspection undertaken. Nothing in this report is a guarantee of compliance with legislation. Where we have identified that there may be contraventions, the comments of the appropriate authority should be sought to assess the scope of remedial work or corrective measures needed to meet requirements.

2. Building services operation

The inspection is visual in nature and excludes specific tests to establish operational status and as such, no assurance can be given that these are free from operational defect. Only the visual condition and state of repair of visible and accessible parts of each system will be assessed and recommendations made for testing or recommissioning, at extra cost, where needed to determine operational condition.

Similarly water quality in closed systems where applicable is assessed from available records, which will be requested and reviewed. The prevailing water quality, condition of internal surfaces of pipework and equipment can only be established by intrusive analysis which would be by a specialist organisation, separately from this report.

3. Suitability of the Property

We are not responsible for commenting on or advising on the suitability for any use, fitness for purpose and performance of the Property and such commentary and advice is outside the scope of the Appointment. The client must therefore ensure that your legal advisors ascertain assurances in this respect, including planning permissions, approvals, permitted uses, limitations etc.

Your legal advisors should advise on whether the Property and or its use, complies with statutes and local byelaws and is not subject to any outstanding enforcement orders or other such notices or proposals

4. Ground conditions and environmental matters

We will not be investigating/reporting on ground conditions and environmental matters in any respect.

5. Budget costs

Any indication of cost is approximate only and relative to the anticipated costs of replacement or repair of a particular piece of building services equipment – it is given as an opinion without detailed measurement or consideration as to how the relevant price of equipment may be packaged and procured in the marketplace. The Client must test such costs by specifying the work in detail and obtaining competitive quotations from appropriate contractors and an exercise of this nature is outside the scope of this Appointment

6. Predicted energy/carbon savings and associated operational costs

The energy and carbon reduction are high level estimations only. They are intended to give a preliminary indication only. Delivered energy and carbon reductions will be subject to factors that are outside the control of this project and cannot be accounted for under this project. All energy and carbon reduction reductions must reviewed and reassessed by an engineer before progressing further into feasibility studies.

Appendix 2 - Acronyms/Abbreviations

ADH	Approved Document H (Building Regulations) – *Drainage and waste disposal*
Bldg	Building
BSRIA	Building Services Research and Information Association
BWIC	Builders-work in connection (with the MEP services)
CAPEX	Capital Expenditure
CCM	Climate change mitigation
CIBSE	Chartered Institute of Building Services Engineers
FW	Foul water (drainage)
LCA / LCC	Lifecycle analysis / Lifecycle costing
LTM	Long Term Maintenance
M&E	Mechanical and Electrical Services
MEP	Mechanical Electrical and Plumbing (Public Health) Services
O&M	Operating and Maintenance (Manual)
OPEX	Operating cost
PPM	Planned Preventative Maintenance
RIBA	Royal Institute of British Architects
RWO	Rainwater outlet
RWP	Rainwater pipe
TB+A	Troup Bywaters and Anders
UoM	University of Manchester
WAG	Whitworth Art Gallery

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Appendix 3 – UK design rainwater intensity

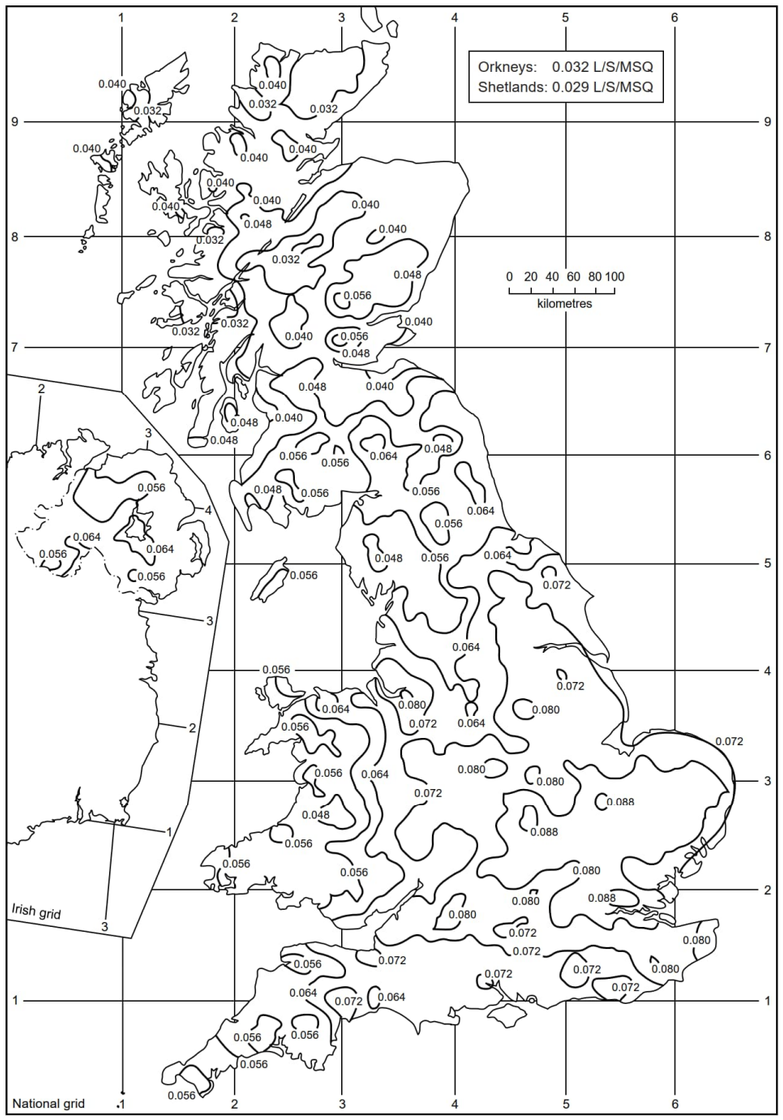


Figure NB.4 — Rainfall intensity, *r*, for a 2 min duration storm event with return period of 500 years (in l/s per m²)

Figure 23 - Extract from BSEN 12056-3

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Appendix 4 – WAG, Roof Catchment Areas

The following table illustrates the roof catchment areas and design flow rate based on 500year return period

Table 3 WAG roof areas and flow rates.

Roof #	Description	Length (m)	Horizontal width (m)	Vertical height of ridge (m)	Horizontal area (m^2)	Vertical area (m^2)	Effective catchment area (m^2)	flow rate (@ 0.064l/s/m^2)
1	Main Roof (Grand Hall), north end	12.5	5.4	4	67.5	50	92.5	5.92
2	Main Roof (Grand Hall), north-central	19	5.4	4	102.6	76	140.6	9
3	Main Roof (Grand Hall), south-central	19	5.4	4	102.6	76	140.6	9
4	Main Roof (Grand Hall), south end	12.5	5.4	4	67.5	50	92.5	5.92
6	North Gallery roof, polycarbonate	20.6	3.9	2	80.34	41.2	101.0	6.47
7	North Gallery roof, slate (incl rooflight)	24.2	4.5	3	108.9	72.6	145.2	9.3
	North Gallery roof, slate (excl rooflight)	24.2	4.5	3			44.2	2.83
8	South Gallery roof, polycarbonate	20.6	3.9	2	80.34	41.2	101.0	6.47
	South Gallery roof, slate (incl rooflight)	24.2	4.5	3	108.9	72.6	145.2	9.3
9	South Gallery roof, slate (excl rooflight)	24.2	4.5	3			44.2	2.83
10	Pilkington Room, main roof, north	13.4	5.8	2.5	77.72	33.5	94.5	6.05
11	Pilkington Room, main roof, south	13.4	5.8	2.5	77.72	33.5	94.5	6.05
12	Pilkington Room, north hip	8.9	3.2	2.5	14.24	11.125	19.9	1.28
13	Pilkington Room, south hip	8.9	3.2	2.5	14.24	11.125	19.9	1.28
							985	63.07

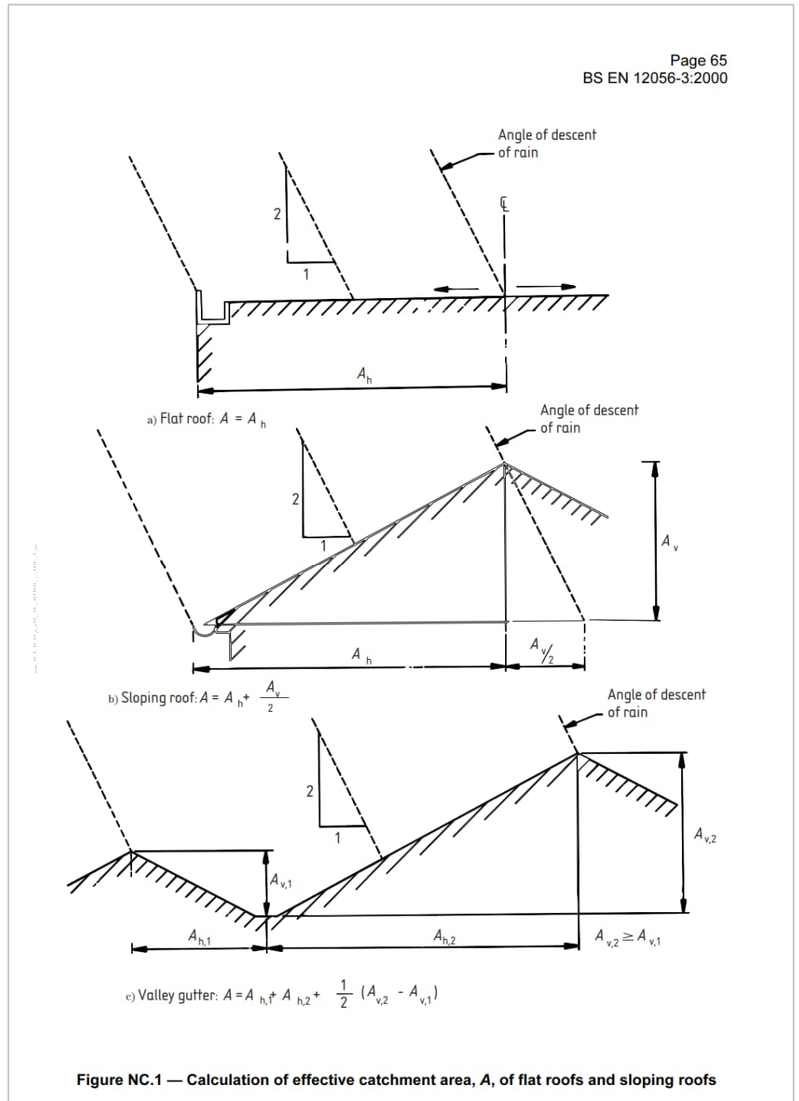


Figure NC.1 — Calculation of effective catchment area, *A*, of flat roofs and sloping roofs

Figure 24 - Extract from BSEN 12056-3, regarding the calculation of catchment area.

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Appendix 5 – WAG, General Arrangement Drawings

As attached.

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Appendix 6 – Residual Risk Register

The below table outlines the perceived health and safety risks at this Stage of the project.

Table 4 - Residual Risk Register

Activity	Hazard	Description of Hazard & Design Measures Taken to Eliminate Or Reduce Hazard	Residual Hazard	Persons at Risk (Construction, Maintenance, Demolition)			Action / Close Out Date
				C	M	D	
Access to roof and roof mounted plant	Falls	At present much of the roof, is provided with access steps etc. All existing access equipment to be reviewed by specialist and new handrails etc proposed if identified as beneficial. Review of existing rainwater goods etc to be carried out; all goods requiring routine inspection to be confined within handrailing and the like.	Risk / hazard is present and is unavoidable	✓	✓	✓	
Working in occupied building	Danger arising from construction work in the vicinity of occupied areas	All works likely to take place in a phased manner in an occupied building. All areas to be decanted where feasible to eliminate risk. All works to be defined closely by method statements on site. Contractors area in north car park to be defined and cordoned off.	Risk / hazard is present and is unavoidable	✓			
Working in areas outside of the site area	Danger arising from deviation from agreed area of work.	All works likely to take place in a phased manner. Any works that need to be carried out outside of what was previously determined as the site boundary, to be agreed with UoM prior to commencement. The Contractor to verify the presence of Asbestos within all areas	Risk / hazard is present and is unavoidable	✓			
Working in area covered by fire-alarm system	Fire detection / alarm compromised	Contractor to liaise closely with UoM to agree the programme of works and method of isolating the fire alarm system. All smoke and heat detectors within the vicinity of the work should be protected with proprietary covers to prevent accidental fire alarm activation. Particularly when isolated, contractor to have fire extinguisher equipment on site at all times.	Risk / hazard is present and is unavoidable	✓			
Blocking of fire escapes and the like	Risk to occupants in an emergency.	Works to be planned so that escape routes are not blocked even on a temporary basis.	Risk / hazard is may be reduced.	✓	✓		
Roof work adjacent to external public areas.	Object falling on occupants	Work around the café external balcony to be planned and temporary closure of such external spaces may be necessary.	Risk / hazard is may be reduced.	✓	✓		
NOTES It is not the intention of this register to identify normal or non-project-specific risks ever-present within the construction industry and which should be self-evident to competent persons on site. All works should therefore be designed and carried out in accordance with the site's Health & Safety procedures and Manuals.							

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Appendix 7 - Our Whole life offer

The schedule below is a menu of services that our in-house teams are able to provide the University as part of our 'whole of life offer' with the currently appointed service(s) identified.

Service	Tick as appropriate	For more information
Architectural Lighting		Architectural Lighting service
Building Performance		Building Performance service
Construction Expert		Construction Expert service
Health + Wellbeing		Health & Wellbeing service
Intelligent Buildings		Intelligent Buildings service
Mechanical + Electrical Engineering Design		M + E Engineering Design service
Strategic Asset Management		Strategic Asset Management service
Strategic Facilities Management		Strategic Facilities Management service
Sustainability		Sustainability service
Technical Project Management		Technical Project Management service

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