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National Trust

Climate Change Adaptation – Buildings

Rainwater Goods

Climate change vulnerability: medium

Rainwater goods – introduction

Rainwater goods can usually be found on our buildings. They help to manage the journey of rainwater and take it away from the building to reduce its adverse impact on the fabric, occupancy and use.

When rainwater goods are in good condition, they help prolong the life of a building. Most buildings in the National Trust (of which there are around 28,500) have gutters, downpipes, hoppers, drains and any number of bespoke detailing around these basics, which keep the building dry when it rains.

When thinking about climate impacts on buildings, the heritage profession often turns towards rainwater goods whether or not the building is significantly affected by climate hazards. This is because we spend a considerable amount of time and resource managing rainwater as the intensity of rainfall increases.

A great deal of wisdom and inventiveness is evidenced in buildings throughout the centuries. In around 1800 the visibility of this grows with the increased use of rainwater goods. By 1900, effective and efficient rainwater goods were standard practice.

Our buildings were designed with wind and rain in mind, but also with regular maintenance in mind. While maintenance has become more expensive and less desirable in short-term budgeting, it is still the most cost-effective approach to sustaining the life of a building.[1] Whatever the size or quality of your rainwater goods, they need to be maintained in order for them to be effective.

For rainwater goods to perform properly, they must also discharge into a receptacle that takes the water away from the base of the building effectively. Whether this is rainwater harvesting, soakaway or engineered systems, these also need to be maintained. This is to make sure that the rainwater goods do not back up or channel water to a place from where it cannot escape, which puts the building fabric at risk by making it susceptible to freeze-thaw action and damp.

Image credits:

Dysfunctional rainwater goods (©National Trust Images/Imogen Wood)

[1] Historic England report on the value of maintenance (https://historicengland.org.uk/images-books/publications/value-of-maintenance/)

Rainwater goods – why do they matter?

Roofs are water shedding, not waterproof. When our shelters and work places or homes leak, it can be devastating. We can see immediately the impacts of overtopping hoppers, broken rainwater goods connections and damp when leaks reoccur.

The use of a building becomes affected by water ingress; for example, through reduced thermal comfort, unsightly appearance and consequences for poor health. The building fabric suffers too as its longevity is significantly affected by wetting and drying, which leads to decay, increased freeze-thaw action and damage to interiors and timbers.

With more frequent, higher intensity rainfall expected, it is vital to recognise the thresholds for change and make use of adaptive windows to address issues. Adaptive windows are time-bound opportunities to implement adaptation measures when other works are taking place. For example, when building works are carried out at roof level, the cost of scaffolding and access may mean that additional work is worth considering and designing into any roof work contracts.

UK traditional buildings have already experienced the impact of high winds and severe storms and are often resilient when well maintained, though some are more vulnerable than others, such as vernacular buildings and church spires.

Sometimes, building managers are ready to replace rather than repair rainwater goods sympathetically. Where there is no maintenance or replacement of rainwater goods, rapid deterioration of building fabric takes place. To meet the climate challenge, we need to instil repair and maintenance regimes that avoid the wholescale replacement of historic fabric. These regimes will need reviewing and underpinning with technology; for example, hoovering gutters and using cherry pickers.

Nevertheless, despite appropriate maintenance, leaves and moss, for example, can be washed off tiles, accumulate and block pinch points. This means that other design changes should be considered for different elements of rainwater goods. This could include measures to buffer and shed water away from the built fabric, avoid water backing up onto surfaces and project water away rapidly from a building during storms.

Along with good design, quality delivery and sign-off of works on completion are essential to avoid tensions arising from defective rainwater goods at a later stage.

To some extent, heat and drought can also impact rainwater goods, as well as other hazards such as landslides, coastal erosion and shrink/swell. Monitoring for changes can help inform adaptive measures and thresholds.

Image credits:

Cerrickfergus Castle (© Department for Communities, NI, Crown Historic Environment Division)

Rainwater goods – hazards, impacts and options

Hazard	Impact	Options
Flooding	Drainage capability to get water away from the building	Ensure soakaways and drainage are maintained and rainwater goods leading to these are in good working order
Heat	Expansion of lead and other materials, material can also become fatigued	Consider increasing the code/gauge of the lead to help it cope with higher stresses, use cast lead rather than sheet lead, increase detailing (steps), consider options for alternative materials, material should be monitored for cracking and other defects with view to replacing
Storm damage – wind	High-impact debris, rainwater goods loosened/dislodged	Monitor and remove tree limbs and possibly crown reduce high-risk trees adjacent to, or overhanging roofs and buildings, clerk of works checks during conservation works, improve fixings if insufficient
Storm damage – high intensity rainfall	Debris build up, overtopping of rainwater goods and lead flashing, pooling causing water ingress, overflowing of outfalls and drainage	Maintain rainwater goods more frequently, consider putting in monitoring systems for hard-to-reach areas and pinch points, consider increasing capacity of gutters (check pinch points and fall of gutters first), leaf guards (not ones which displace capacity), overshot gutters, increased number/capacity of hoppers, repairs to downpipes and connections where leaking
Landslide/coastal erosion/shrink/swell	Subsidence and potential full/partial collapse of building and associated features, possible discrete changes to levels, falls and connections of rainwater goods	Monitor after any noticeable events, have an adaptive pathway policy plan in place for buildings considered at high risk and vulnerable to impacts (those in clay beds, within coastal erosion zones)
Freeze-thaw and snow	Materials pushed out/cracked	Electrical current along rainwater goods (check ecological implications) during sub-zero temperatures and snowfall

Rainwater goods – options and thresholds

Climate change affects the ability of rainwater goods components to cope with rainfall. Where maintenance regimes are poor or lacking, climate processes multiply the risk and exacerbate issues already caused by deterioration.

Thresholds should only be explored where maintenance is active, condition is good and components of rainwater goods are not defective, but they are consistently overcome by rain that impacts negatively on the fabric or use of the building or structure.

Specific options for building resilience and adaptive changes include:

Adaptive release & managed decline – some buildings can be maintained in perpetuity, but others were not built to last or have suffered an event that has left them in ruinous condition. Gradually affected by natural processes until they deteriorate, many of our ruins and castles are roofless so that measures such as soft capping, re-pointing and preservation by record can be a pathway towards adaptive release.

Maintenance – sometimes the built environment is not well maintained and the most effective approach to resist climate hazards and impacts, and to improve the site's adaptive capacity is to activate a regular maintenance regime. This is likely to be both planned and reactive; for example, snowfall and storms trigger clearance of blockages and checks for defects, alongside routine clearing and cleaning to keep rainwater goods functioning and effective at getting water away from the building.

Catch pits – instead of using lead, which is vulnerable in this particular use, alternative materials could be explored with a conservation professional. The pit is often hidden so consider fabricating a piece in glass fibre or terne-coated stainless steel, which would be far less vulnerable to high heat stress and freeze-thaw. Deepening the catch pit, if permissible and feasible, may assist in coping with higher intensity rainfall.

Hoppers – as well as being a buffer between outfall from a large surface area and a small downpipe, hoppers are often decorative and prominent on large buildings, and therefore changes need to be sensitive to the design and their detailing. Hoppers can be blocked, overwhelmed and often result in water backing up lead valleys or overflowing onto the building fabric. Modifications such as overshoots to encourage water away from the building and avoid these impacts are desirable in adapting to climate hazards.

Gutters/rhones – where laid at too much of a fall, gutters do not have the right relationship with the roof. Ideally, the edge of the roof covering should meet with the gutter so that water sheds perfectly into it. Laying the gutter relatively flat to catch more water coming off the roof and having hoppers in the right places should cope with rainfall now and in the future. Protection from ice and snow is also important. Interventions such as duck boards are not recommended as the rails and inserts reduce the size of the gutter by as much as two thirds and therefore make it relatively incapable of coping with rainfall. Trace heating could be used to provide enough thaw to help the gutter run.

Cameras – for very hard to reach and vulnerable spots, tiny cameras could be installed or drones can monitor for impacts/issues with high-intensity storms.

Thresholds & tipping points

At what point might you diverge from your current maintenance/management strategy? What are the events/ impacts that may trigger this change of approach (action/ philosophy)?

- Frequency of maintenance interventions
- Adaptive windows associated with roofing projects and condition surveys where an opportunity arises to consider resilience
- Vandalism can often impact rainwater goods when lead is targeted and may trigger considerations for design changes to rainwater goods where synergies can be found for roof coverings
- Recurring ingress despite rainwater goods being well maintained.
- Ingress impacting use or internal fabric (where these cannot be changed)

Maintenance is crucial, but where options and interventions are proposed, statutory consent may be required if the special architectural or historic interest of the building is affected by the proposed change. The building may be scheduled and therefore scheduled monument consent will be needed for most changes.

Maintaining difficult to access rainwater goods is forever challenging, particularly at high-level and dangerous areas. Any changes to rainwater goods are likely to need listed building or scheduled monument consent, where applicable, and may also need planning permission. Drainage may affect archaeology and changes to roofs may impact bats (protected). These should be considered at the feasibility stage and not simply mitigated for pre-implementation.

Rainwater goods – worked pathway example

This application of pathways and thresholds to a real site example shows how and when your adaptive response to climate hazards may change and evolve.

Working with a multi-disciplinary group to think about options and thresholds for a typical site is key. This cannot be done in isolation as there are significant implications for impacts on more than one aspect; for example, ecology and aesthetics. It is better to bring together the right people to work on a mutually acceptable solution for a period of time between thresholds for change.

While the ability of rainwater goods to move water away from the built structure as quickly as possible is the primary aim of adaptive changes, the aesthetic of these details are often fundamental to the significance of the building and can have serious negative impacts if not designed appropriately and with suitable materials. There are also synergies from large water-shedding structures, such as water storage and efficiency, which are worth considering as part of any climate adaptation project. Either way, significance should always inform the approach.

Options must not be selected without considering the unique characteristics, significance, vulnerabilities and use of your specific requirements, and this may mean that different adaptive pathways apply to each site.[2] The worked example below is based on the current rainwater goods for the principal mansion at Erddig, National Trust. The rainwater goods are well maintained and the design has an interesting variation of how much flow is directed towards different hoppers and downpipes. The purpose of the pathway is to explore options for change and build resilience if the current design becomes poor at performing its function in the face of precipitation changes (not because of poor maintenance).

Adaptive release

Major re-design of roof and rainwater goods

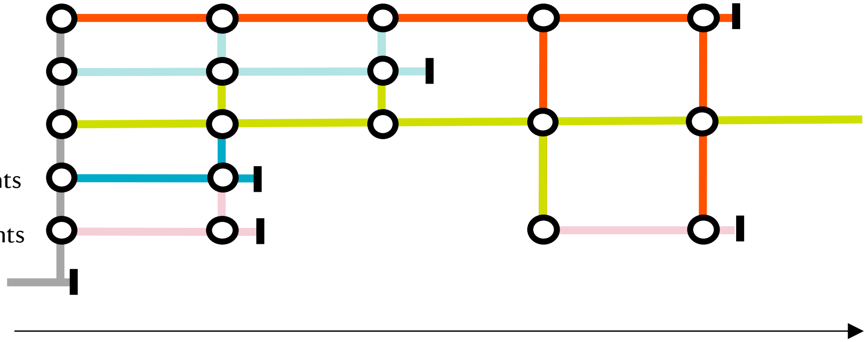
Major re-design of rainwater goods

Up capacity of rainwater goods at pinch points

Minor rainwater goods changes at pinch points

Maintain rainwater goods

Time/impacts



(Response thresholds are most likely to be based on the frequency of water ingress (where lack of maintenance is not found to be the cause), linked to the occupancy, fabric impacts and use of the building. The specific trigger points would need to be agreed by both the operations decision-maker and relevant consultants, and consultees such as the conservation officer or buildings inspector covering a site).

Image credits:

Bird mess and leaf litter have been clogging up drainage protectors, causing water to back up and cause leaks from the internal rainwater goods into the museum at Berwick Barracks. The rainwater goods are now being cleared out 10 times a year and the fine mesh protectors have been replaced with larger aperture lead guards. There is a longer term need to increase the size of downpipes and hoppers (© English Heritage Trust)

[2] Dynamic Adaptive Policy Pathways Approach
(Haasnoot, Kwakkel, Walker & Ter Maat)

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Case studies, signposting and references

These case studies show adaptation in action and the approaches that have been tried out across different types of charitable trusts and properties in care in the UK.

At Carrickfergus Castle, Department for Communities, Northern Ireland, the new roof replaces the flat roof of the great hall, which was added in the 1930s. Over time, water had settled on the flat roof and seeped into the walls, causing leaks and mould to grow. This has been solved by the new roof which has been built to last from a wind-thrown 17th-century oak, Cumbrian stone slate and lead. All materials are traditional and appropriate to the site, specified and built to last.[3]

The Queen Anne Casemates are vaulted stone apartments at Stirling Castle adjacent to the Queen Anne Gardens. The area over the vaults, which serves as a visitor walkway, was previously surfaced with a mix of grass and flagstones. Investigation confirmed the original asphalt tanking layer had deteriorated and rainwater goods were failing. Together with climate change impacts of increased rainfall patterns, water ingress into the vaults below was increasingly leading to degradation of historic fabric and threatening electrical equipment. The surface finishes have been replaced with a new asphalt waterproofing layer, which has been extended above surface level and raggled into varying stone joints in the parapet walls. Full-length whinstone channels now allow improved rainwater run-off.

At Ebworth (National Trust) all rainwater was draining to a small number of downpipes causing flooding and overtopping at pinch points. An open gulley was put into the floor outside to help channel water away from both the building and hard standing nearby.

The conservatory at Cliveden (National Trust) required changes to the rainwater goods as a result of increased rainfall. The building was originally served by narrow cast-iron internal downpipes, which frequently became blocked in heavy rain and led to numerous floods in the building. The project allowed reconfiguration of the rainwater disposal strategy, designing a series of external downpipes to the east side of the building and altering the fall of valley gutters and the box gutter. This allowed more easily accessible and visible rainwater goods, which are conducive to regular maintenance.

Before

After

Signposting & other guidance of relevance/use

Historic England has produced guidance on replacement metals where lead theft is an issue. Useful in considering design changes where lead is suffering climate stresses. https://historicengland.org.uk/images-books/publications/theft-metal-church-roofs-replacement-materials/

Historic Environment Scotland has a broad guidance document on traditional building adaptation. https://www.historicenvironment.scot/archives-and-research/publications/publication/?publicationId=a0138f5b-c173-4e09-818f-a7ac00ad04fb

When considering change to building and structures, there are likely to be many implications for the historic and natural environment, as well as access, drainage, flooding and infrastructure. Always **consult a historic environment specialist** (such as a curator and a building surveyor), a natural environment specialist (such as an ecologist) as well as planning consultants, engineers and your local statutory bodies to check the implications of any proposal. It is very likely that Listed Building or Scheduled Monument Consent would be needed to agree any changes where applicable.

[3] DfC website: Carrickfergus Castle – Works to the Great Tower Roof (Crown Historic Environment Division) (https://www.communities-ni.gov.uk/articles/carrickfergus-castle-works-great-tower-roof)