

Guidance Document for Built Asset Climate Change Risk Assessment (CCRA) and Adaptation Planning

Report No: 997

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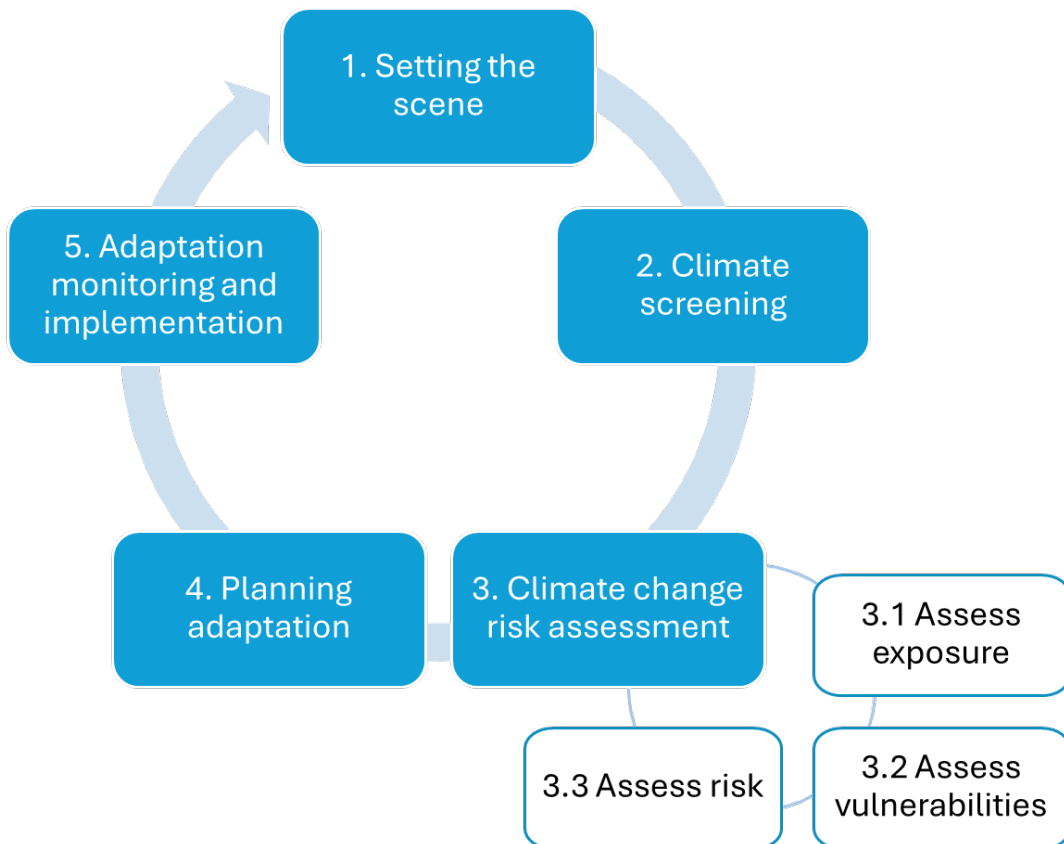
Crynodeb Gweithredol

Datblygwyd y ddogfen ganllaw hon i ddarparu dull cyson y gellir ei ailadrodd o asesu a rheoli risgiau newid hinsawdd ar draws ystad Cyfoeth Naturiol Cymru. Mae'n darparu dull strwythuredig ar gyfer nodi, asesu a rheoli risgiau sy'n gysylltiedig â'r hinsawdd ar lefel yr adeilad, a nodi mesurau addasu effeithiol ac ymarferol.

Mae'r fethodoleg a amlinellir yn y ddogfen hon yn berthnasol i ystad CNC. Fodd bynnag, mae'r ystad yn amrywiol ac mae gwahanol fathau o adeiladau yn cyflwyno heriau a chyfleoedd unigryw. I fynd i'r afael â hyn, mae adrannau perthnasol y canllawiau'n cynnwys enghreifftiau darluniadol wedi'u teilwra i ddefnyddiau a mathau penodol o adeiladau.

Mae'r canllawiau'n tynnu ar fframweithiau blaenllaw, gan gynnwys Fframwaith Addasu Ystadau Swyddfa'r Cabinet a Fframwaith y Cyngor Adeiladau Gwyrdd ar gyfer Mesur ac Adrodd ar Risg Hinsawdd Ffisegol. Drwy integreiddio'r dulliau hyn, ei nod yw cefnogi gwneud penderfyniadau gwybodus, gwella gwydnwch, ac aliniad â safonau cydnabyddedig ar gyfer addasu i'r hinsawdd a rheoli risg.

Mae Ffigur 1 yn dangos y broses a amlinellir yn y canllawiau hyn ar gyfer cynnal asesiad risg newid hinsawdd ar gyfer asedau adeiledig a chynllunio addasu.



Ffigur 1. Proses ar gyfer cynnal asesiad risg newid hinsawdd ar gyfer asedau adeiledig a chynllunio addasu.

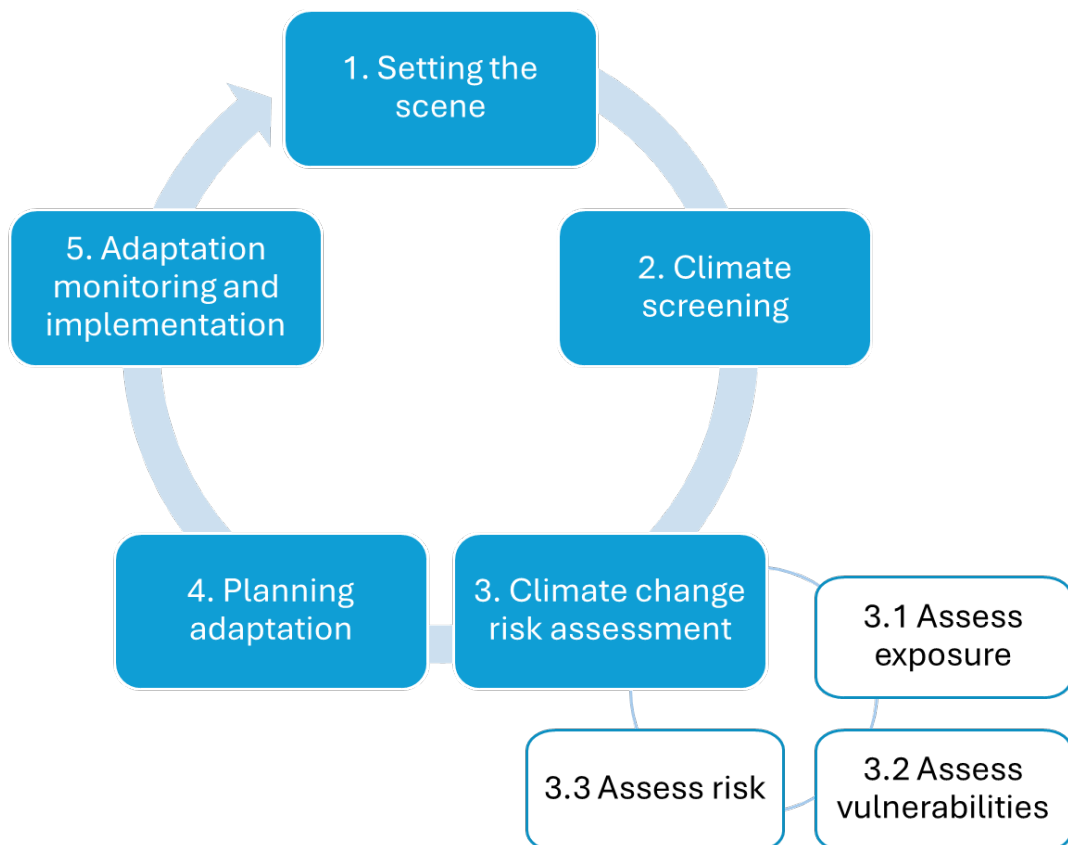
Executive Summary

This guidance document has been developed to provide a replicable and consistent approach to assessing and managing climate change risks across the NRW estate. It provides a structured approach for identifying, assessing, and managing climate-related risks at the building level, and identifying effective and practical adaptation measures.

The methodology outlined in this document is applicable to NRW’s estate. However, the estate is varied and different building types present unique challenges and opportunities. To address this, relevant sections of the guidance include illustrative examples tailored to specific building uses and types.

The guidance draws on leading frameworks, including the Cabinet Office Estates Adaptation Framework and the Green Building Council Framework for Measuring and Reporting Physical Climate Risk. By integrating these approaches it aims to support informed decision-making, enhance resilience, and align with recognised standards for climate adaptation and risk management. Figure 1 illustrates the process outlined in this guidance for carrying out built asset climate change risk assessment and adaptation planning.

Figure 2. Process for conducting climate change risk assessment for built assets and adaptation planning.



1. Setting the scene

Steps	Data Needs	Outcomes	Additional Guidance
<ol style="list-style-type: none">1. Define scope of the assessment2. Describe existing understanding of climate change impacts to the site	<ul style="list-style-type: none">• Existing available information to understand climate impacts affecting the site e.g. organisational plans/strategies/policies, design thresholds, asset condition data, occupancy patterns, records of previous incidents	<ul style="list-style-type: none">• Clear definition of the context for the assessment, with future scenarios, assets to be included and underlying assumptions agreed.	<ul style="list-style-type: none">• RCP scenario guidance• UKCP18 product guidance• ISO 14091:2021

Purpose of setting the scene

Setting the scene is an important early step in a climate change risk assessment, helping to ensure that the assessment is relevant, proportionate, and clearly aligned with its intended purpose. This stage establishes the context for the assessment, which may include building on the findings from previous assessments, responding to specific programmes or organisational objectives (such as prioritising sites across an estate for management or development), or meeting external reporting requirements, including Adaptation Reporting Power (ARP) submissions and climate risk disclosures aligned with the Task Force on Climate-related Financial Disclosures (TCFD). By clearly defining scope, drivers, and assumptions at the outset, the risk assessment can focus on the most material climate risks and support effective decision-making.

Approaches to setting the scene

In this section, the assessment scope is clarified by specifying the objectives, boundaries and future scenarios to be considered, along with any key assumptions that will guide the process. Current understanding of climate change impacts on the site is also compiled, drawing on available evidence such as historic weather-related incidents, previous assessments, and identifying available data sets that can be used in the subsequent stages.

Define scope of the assessment

At the outset of developing a climate change risk assessment, it is important to clearly define the scope to ensure a focussed assessment that is proportionate and aligned with decision-making needs. The objective of the assessment should be clearly understood, and will determine the level of detail required. For example, the assessment may be intended to:

- Inform strategic decisions such as asset retention, disposal, or acquisition
- Support maintenance planning and prioritisation of future investments
- Respond to climate risk reporting or disclosure requirements
- Address risks highlighted by a specific event, incident, complaint, or in a risk register
- Understand potential impacts on operations, service delivery, or supply chains perceived to be at risk

It is also necessary to define the boundaries of the assessment to avoid unintended scope creep and keep the assessment proportionate. This includes setting out what is included and excluded, such as whether the assessment is:

- Site based or portfolio wide
- Focused on all buildings within a site or specific assets
- Limited to physical assets, or extended to include people, activities, and supporting services (e.g. staff, contractors, or supply chains)

The timeframe over which climate risks are considered should also be established. This may include short-, medium-, and long-term horizons, depending on the nature of the assets, operational planning cycles, and strategic objectives. The chosen time horizons should be appropriate to the decisions the assessment is intended to inform. It is generally recommended to include a longer-term view to the end of the century as assets that have shorter lifespans are often in place longer than planned.

The climate change scenarios to be used in the assessment should be identified, as this will influence the climate data products and evidence to be drawn upon. Good practice in climate change risk assessment is to consider a range of scenarios, reflecting different potential future pathways and helping to explore sensitivity and uncertainty of climate projections. Representative Concentration Pathways (RCPs) are recommended to use as a basis for future climate change scenarios as they offer a range of possible futures. The 2018 UK Climate Projections (UKCP18) are aligned with RCPs and offer a wide range of publicly accessible datasets and products. More information about RCPs is available in Appendix B.

Finally, it is important to acknowledge that climate risk assessments are inherently uncertain. Consideration should be given to how uncertainty will be managed and communicated, for example by using multiple climate scenarios or confidence ratings. Being explicit about uncertainties supports transparency and helps decision makers interpret the findings appropriately.



Top Tip:

It is recommended to assess projections for a moderate climate scenario (RCP4.5) and a 'worst case' climate scenario (RCP8.5) for a range of time periods such as the 2030s (2021-2050), 2050s (2041-2070) and 2080s (2071-2100), comparing against a baseline period such as the 1990s (1981-2010).

Describe existing understanding of climate change impacts to the site

Any available information about the organisation's existing understanding of how climate change may affect the site, its assets and/or operations should be collated. This may include any existing policies, known risks or existing adaptation actions in order to provide a baseline from which gaps can be identified, avoids duplication of existing work, and aligns the assessment with existing priorities. Relevant documents to review could include:

- Climate adaptation or resilience strategies
- Climate risk registers
- Net zero or decarbonisation plans
- Asset management strategies
- Business continuity plans.

Any known design standards or thresholds should also be identified. Thresholds can later be used to link climate projections to the likelihood of disruption or loss of service and may include:

- Design standards e.g. rainfall intensities beyond which drainage systems fail
- Operational limits or performance thresholds e.g. maximum acceptable indoor temperatures

An initial review of available internal and external data sources should also be undertaken to identify what data already exists, its quality, and any gaps to help shape subsequent steps in the assessment. Internally, this may include data on:

- Asset locations
- Building age
- Building materials and condition
- Energy and water consumption
- Maintenance records
- Occupancy patterns,
- Records of previous weather-related incidents.

Externally, relevant datasets may include:

- Climate projections
- Historical weather data
- Flood risk mapping
- Coastal erosion mapping
- Topography
- Other relevant geospatial layers.

Finally, it is important to identify the key stakeholders who should be involved in, or informed by, the assessment, and how they should be engaged. Engaging with stakeholders early in the process helps ensure the assessment is informed by operational knowledge, supports shared ownership of findings, and increases the likelihood that outputs are effectively embedded into decision making. Stakeholders may include:

- Asset and facilities managers
- Planning teams
- Operational leads
- Health and safety representatives
- Sustainability or climate specialists
- Key decision makers.
- External stakeholders such as service providers, suppliers, local authorities, or regulators

2. Climate Screening

Steps	Data Needs	Outcomes	Additional Guidance
<ol style="list-style-type: none">1. Explore site-specific vulnerabilities to climate hazards2. Examine site exposure3. Identify priority hazards4. Define risk statements5. Prioritise risk statements	<ul style="list-style-type: none">• Local site knowledge• Climate change projections• Hazard mapping	<ul style="list-style-type: none">• Identification of sites/assets requiring more detailed assessment• Risk statements defined	<ul style="list-style-type: none">• <u>Past weather events</u>• <u>CCRA3</u>• <u>UKGBC</u>• <u>Local Authority Climate Service</u>

Purpose of climate screening

The screening stage should be a relatively high-level process, looking at a broad range of climate hazards and risks and identifying the most significant ones to be carried through for further assessment. It is an important step to prioritise effort and resources for the subsequent, more detailed, climate risk assessment stage. Screening may build on existing evidence, including previous organisational or national-level risk assessments to support a more rapid process. It may also be informed by the knowledge and experience of stakeholders within the organisation, who may have valuable insight into past and emerging climate related impacts. The outputs of this stage are used to identify sites and hazards that warrant more detailed analysis.

Approaches to climate screening for site-based risk assessments

There are several approaches that may be adopted during the climate screening stage. However, this guidance centres its approach on understanding site vulnerability and exposure to future climate hazards in order to identify sites and assets most at risk, and therefore requiring more detailed assessment.

Explore site-specific vulnerabilities to climate hazards

Vulnerability in this context describes *the propensity or predisposition of assets, operations or people to be impacted by climate hazards*. Insights from staff with local site knowledge, e.g. Facilities or Asset Managers, are particularly valuable in understanding site-specific sensitivities. This may include operational constraints, past incidents and known weaknesses that are not evident from broadscale datasets.

Building an initial understanding of vulnerabilities may include:

- **Reviewing internal documents and data** gathered during the setting the scene stage. This may include asset condition data (e.g. building age and materials), maintenance records or occupancy patterns to identify known weak points.
- **Review records of past extreme weather events** to build a timeline of incidents that have previously impacted the site. This may include internal records, local news reports or Met Office reports of past weather events.
- **Engaging with Facilities, Asset and Operations Managers** to understand local site processes and constraints or any knowledge of climate-related issues that may not be formally recorded.

Vulnerabilities should be recorded against each climate hazard. A selection of illustrative examples of building vulnerabilities based on building uses across the NRW estate are available in Appendix D. By reviewing site-specific vulnerabilities, it is possible to build an initial understanding of how different climate hazards have previously affected the site, and how they could potentially do so in the future.

Examine site exposure




Exposure is *the extent to which an asset, operations, or people are subject to climate hazards based on their location*. It can be assessed by considering projected long-term trends in climate hazards, drawing on climate projection datasets such as the UK Climate Projections ([UKCP18](#)), UK Climate Risk Indicators ([UK-CRI](#)), national-scale hazard mapping such as [flood risk maps](#) and other geospatial information.

For the purposes of screening, focussing on a high-emissions future scenario (for example RCP8.5) for the 2080s, where data are available, provides a conservative view of potential future exposure. Record the direction and approximate magnitude of change of each hazard from the baseline period (e.g. 1981-2010) to identify whether exposure is likely to increase, stay broadly consistent, or decrease by the end of the century.

Identify priority hazards

By reviewing the combined findings on vulnerabilities and exposure, it is possible to identify which climate hazards are emerging as priorities for more detailed analysis. Considering vulnerability and exposure together highlights the hazards that show both a strong projected change and susceptibility at the site, allowing them to be taken forward into the risk assessment stage, while those without significant change projected or low potential impact may be screened out. An example of how this may be presented, taken from the Resolven CCRA, is shown in Figure 2.

Figure 3. Example climate screening summary table. Source: Resolven CCRA

Climate hazard	Perceived risk level (staff input & site visit)	Projected hazard trend (2080s RCP8.5)	Comment	Screening outcome (in/out)
High temperatures / heatwaves	Low	 Annual maximum temperature (°C)	Projections indicate annual maximum temperatures could increase 5.3°C by the 2080s (RCP8.5). Although high temperatures are currently seen as a low concern, future projections show they will rise. This could increase thermal stress on building materials and raise health risks from overheating.	In
Low temperatures	Low	 Annual minimum temperature (°C)	Projections indicate annual minimum temperatures could increase 4.1°C by the 2080s (RCP8.5). Periods of low temperatures are currently well managed and projections indicate they will become less frequent. Fewer cold snaps mean lower heating demand and reduced risk of cold-related damage to building materials.	Out
Wildfire	High	 Met Office Very High Fire Danger (days/year)	Projections indicate the number of days with very high fire danger could increase by 33 days by the 2080s (RCP8.5). Wildfire is considered a high risk due to the site's location and building materials, and projections indicate this hazard is increasing. Greater wildfire risk could affect air quality, disrupt site access and damage building exterior and roof.	In

Alternative approaches to hazard screening

There are a number of alternative approaches that can be used to support rapid climate hazard screening which can be particularly useful where detailed datasets are unavailable. Two alternative approaches are described below:

- 1. Use of national urgency/priority ratings (e.g. CCRA3)**

The UK Climate Change Risk Assessment ([CCRA3](#)) provides urgency scores indicating whether risks are “more action needed”, “further investigation”, “sustain current action” or “watching brief”. These ratings can offer a high-level indication of which hazards may warrant closer attention.

- 2. Climate services tools**

The Met Office [Local Authority Climate Service](#) provides locally tailored climate information such as reports and projected changes in key climate metrics. These tools allow users to quickly explore how climate hazards are projected to change in their area, supporting rapid climate screening.

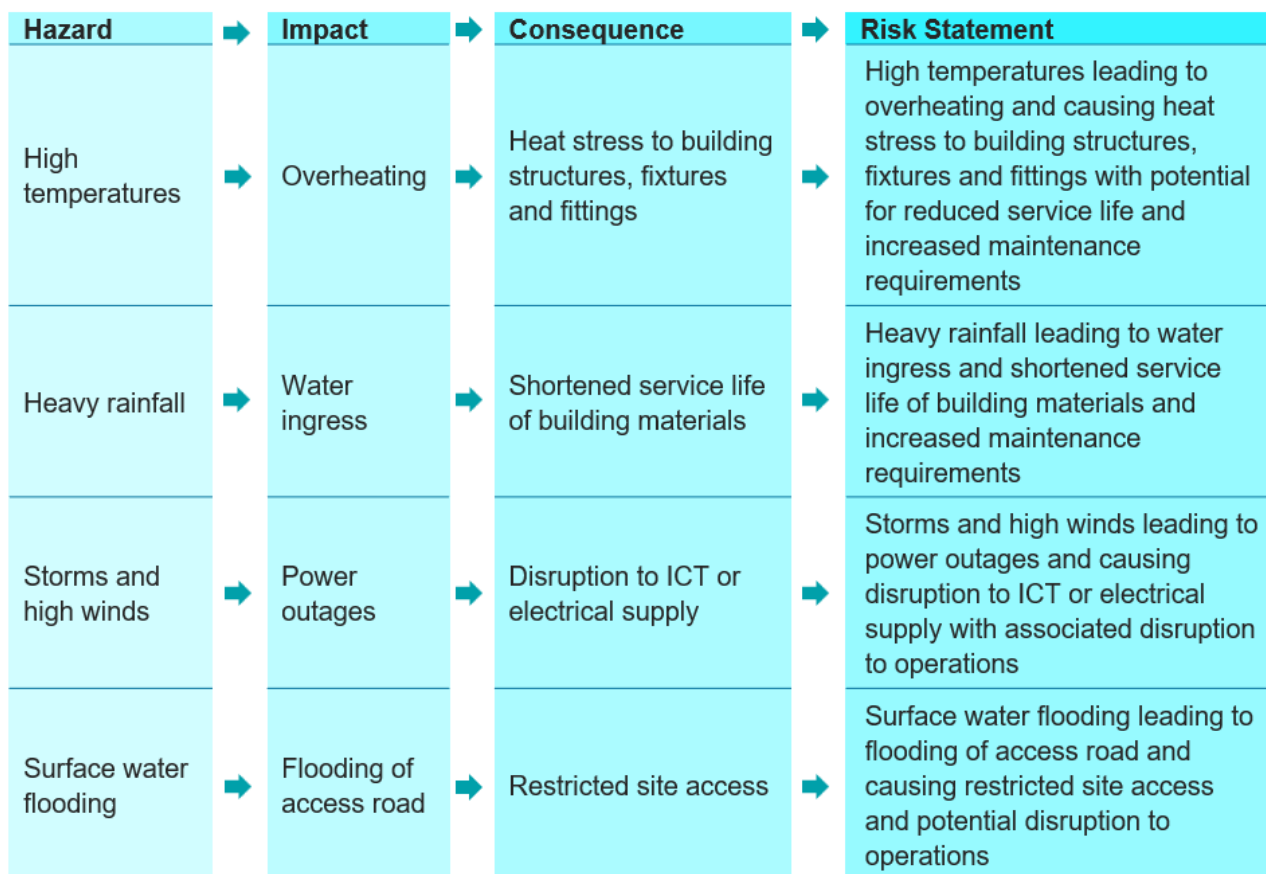
Define risk statements

It can be useful at the screening stage to develop risk statements that describe how climate conditions could affect the site's assets, operations or people. Risk statements provide a common structure that bring together the findings from the steps above into a clear summary of how each priority climate hazard could impact the organisation. Developing these statements early supports prioritisation and scoring in the subsequent risk assessment stages. Risk statements should be specific and, where possible, reference both the hazard and the resulting impact or consequence for the asset or organisation if the hazard were to occur. They may draw on:

- Site specific knowledge (e.g. from site visits, discussions with Facilities Managers, building condition surveys)
- Relevant national assessments, such as the UK Climate Change Risk Assessment (CCRA)
- Relevant risk assessment frameworks, such as the UK Green Building Council (UKGBC) Climate Risk Assessment Framework

To support the development of risk statements, a selection of illustrative examples are provided in Figure 3 for office-type buildings. Further examples for different building types based on their use are provided in Appendix C. The examples are not exhaustive but show how a risk statement can be developed by collating information on the hazard and impact or consequence.

Figure 4. Example process for developing risk statements for office-type buildings.



Prioritise risk statements

In the previous step (define risk statements), a long list of potential risks is developed which then requires prioritisation. This prioritisation can be guided by both the severity of the site-specific vulnerabilities identified and the projected trends in relevant climate hazards. Applying these criteria helps ensure that the subsequent climate change risk assessment remains focussed on the most significant risks. In turn, this supports the effective allocation of resources and enables later adaptation planning to be both targeted and impactful.

3. Climate change risk assessment

This chapter sets out the approach to undertaking a climate change risk assessment for a single site, building on the outputs of the screening stage, to provide a more detailed understanding of priority risks. In this context, climate risk refers to *the potential for a climate hazard to cause harm to assets, operations or people, arising from the combination of the site’s exposure to the hazard and its susceptibility to its effects.*

For single-location, site-based assessments, exposure is assessed through the projected trend in climate hazard. This is informed by climate projections and other relevant datasets. However, where assessments are undertaken across multiple sites, such as an estate, a comparative consideration of exposure between different sites is required to quantify how the incidence of particular hazards may change (e.g., a site at higher elevation will be less exposed to extremely hot conditions, than a site located in a highly urbanised environment).

The following sections describe the approach to assessing exposure, vulnerability, and overall risk in more detail, and sets out how these components are combined to provide a consistent and proportionate assessment of climate change risks.

Assess exposure

Steps	Data Needs	Outcomes	Additional Guidance
1. Select datasets to assess exposure	<ul style="list-style-type: none">• Baseline climate observations	<ul style="list-style-type: none">• Exposure indicators defined	<ul style="list-style-type: none">• <u>Extreme Value Analysis</u>
2. Select indicators to explore future climate conditions	<ul style="list-style-type: none">• Climate change projections	<ul style="list-style-type: none">• Likelihood scoring applied	<ul style="list-style-type: none">• <u>Flood Estimation Handbook (FEH)</u>
3. Score exposure	<ul style="list-style-type: none">• Geospatial hazard mapping		<ul style="list-style-type: none">• <u>ISO 14091:2021</u>
4. Communicate uncertainty	<ul style="list-style-type: none">• Asset location data		

Purpose of exposure assessment

Exposure refers to *the extent to which a site, its assets, operations or people are subject to climate hazards.* An assessment of exposure evaluates the extent to which a climate related hazards may affect the site, based on the scenarios and time periods defined during the initial setting the scene stage. The hazards to be assessed should already have been scoped in during the preceding climate screening stage.

Approach to exposure assessment

This section introduces a range of datasets available to support assessment of exposure, approaches to developing and scoring exposure metrics, communicating uncertainty and the use of Extreme Value Analysis (EVA).

Select datasets to assess exposure

The exposure assessment may use a range of datasets to understand baseline conditions and projected future hazard trends. Common sources include:

- **Baseline climate observations**, such as historical temperature and rainfall records from the Met Office.
- **Met Office UKCP18 climate projections**, providing probabilistic and ensemble projections of future climate conditions under multiple emissions scenarios.
- **UK Climate Risk Indicators (UK-CRI)**, which provide ready-made exposure metrics (e.g. heatwave frequency, cooling degree days, drought indices) for baseline and future periods.
- **Flood risk datasets**, such as those provided by Natural Resources Wales, including river, surface water, small watercourse, and coastal flood mapping.
- **British Geological Survey (BGS) geohazard layers**, including landslide susceptibility, shrink–swell clay and groundwater related subsidence.
- **Ordnance Survey open data**, including land use and infrastructure layers.

Selecting data depends on the climate scenarios, time periods and spatial scale required for the analysis. Where possible, datasets should be chosen to align with the scope outlined in the setting the scene stage. Any gaps in that data, uncertainty or limitations should be clearly reported.

As an example, the CCRA for Resolven used UK-CRI indicators to assess exposure. Data was downloaded for the relevant 12km grid cell using the UKCP18 Probabilistic strand to ensure alignment with the chosen climate scenarios (RCP4.5 and RCP8.5).

Select indicators to explore future climate conditions

For each priority risk statement identified during screening, an appropriate exposure indicator should be selected to represent the occurrence or severity of the related hazard under future climate conditions. Indicators may include:

- **Threshold based metrics**, such as the number of days exceeding a critical temperature.
- **Operational metrics**, such as the number of days where water levels exceed operational thresholds, affecting equipment use or prompting temporary closure.
- **Frequency based metrics**, such as projected increases in the frequency of heavy rainfall events.

UK-CRI indicators provide a useful starting point for indicators because they are standardised, nationally consistent and available for multiple future periods and emissions scenarios.

Score exposure

Scoring exposure is a key step in determining how strongly climate hazards may affect the site. As the indicator values used to infer exposure vary, they are standardised to a 1-5 scoring system. There are several methods that can be used to develop scoring bands including equal intervals, quintiles, or custom scoring bands. In the CCRA for Resolven, equal interval bands were used where the full range of indicator values is divided into evenly sized categories (e.g. 1–5 or very low to very high). To avoid overstating risk, the ranges are based on a wider geography (i.e. maximum and minimum values taken for each indicator across Wales, England and Wales, or UK wide) rather than just localised values.

Not all hazards fit into an equal interval classification, for example flood risk may be based on return periods or annual probability. An example 1–5 scoring scale is shown in Table 1 including example scoring bands using an equal interval classification, return periods and annual probabilities. Scoring should be applied across the baseline and all future scenarios.

Table 1. Example equal interval, return period and annual probability scoring classes used to categorise the occurrence of climate hazards.

Class	Category	Equal Interval	Return Period	Annual Probability
5	Very High	>4 days	> 1 in 10 year	>10%
4	High	3-4 days	1 in 10 year – 1 in 30 year	3.3% - 10%
3	Medium	2-3 days	1 in 30 year – 1 in 100 year	1% - 3.3%
2	Low	1-2 days	1 in 100 year – 1 in 1000 year	0.1% - 1%
1	Very Low	<1 days	< 1 in 1000 year	<1%

Communicate uncertainty

Uncertainty is an inherent part of climate exposure assessment. To maintain transparency and support robust decision making, uncertainty should be recorded and communicated clearly. This may include:

- Assigning uncertainty ratings (e.g. low / medium / high) based on data quality and confidence in projections
- Using multiple climate scenarios to capture a range of plausible futures and reduce reliance on a single emissions pathway
- Documenting assumptions and limitations, such as data gaps

Optional step: Conduct extreme value analysis (EVA)

In some cases, such as when an asset is known to be highly sensitive to a particular hazard threshold and it is important to know how often that threshold may be exceeded, it may be appropriate to consider Extreme Value Analysis (EVA). This approach is especially relevant for hazards where rare but severe events can have major operational or safety implications, such as extreme rainfall, heatwaves or high wind speeds. EVA supports understanding of plausible worst-case scenarios and helps assess resilience to low-likelihood, high-consequence events.

This can be especially relevant for organisations involved in emergency response, such as Natural Resources Wales, where planning for extreme but plausible events is necessary for operational resilience. EVA uses statistical techniques to understand the likelihood of extreme values occurring over a given time period. More detail about EVA is available in:

- Met Office [Extreme Value Analysis](#)
- UK Centre for Ecology & Hydrology (CEH) [Flood Estimation Handbook \(FEH\)](#)

Assess Vulnerabilities

Steps	Data Needs	Outcomes	Additional Guidance
1. Assess known sensitivities	<ul style="list-style-type: none">• Building condition information	<ul style="list-style-type: none">• Overall site vulnerability scores (1–5)	<ul style="list-style-type: none">• ISO 14091:2021
2. Assess building or site criticality	<ul style="list-style-type: none">• Operational insights	<ul style="list-style-type: none">• scores across baseline and future time periods	
3. Calculate vulnerability score	<ul style="list-style-type: none">• Information on service delivery requirements and operational criticality		

Purpose of vulnerability assessment

The vulnerability assessment is an important step in understanding how buildings and assets within the built estate may be affected when exposed to climate hazards. It may involve assessments of sensitivity (*how strongly an asset may be affected by a risk*) and criticality (*the severity of the consequences if a risk were to occur*). Sensitivity also considers the adaptive capacity of an asset, which is *the ability to adjust to reduce potential damage or enhance recovery from the impacts of a climate hazard*. This assessment should draw on a range of evidence, including condition information from building surveys, operational knowledge, and insights from site staff. It should also consider the importance of each asset to NRW's service delivery and site functions, helping to identify priority areas where impacts are more severe and where adaptation planning should be focussed.

Approach to vulnerability assessment

There are varied approaches to scoring vulnerability. The approach described here comprises a qualitative assessment of both sensitivity and criticality, with each scored separately before being combined to form the overall vulnerability score of an asset, building, or site.

Assess known sensitivities

Sensitivity is assessed by considering how each building or asset is likely to be affected by the climate hazard relevant to each priority risk statement identified during the climate screening stage. Where available, building condition surveys (e.g. building fabric and mechanical and electrical equipment surveys) provide a valuable evidence base, including information on:

- Existing damage from climate-related events
- Materials and their current performance
- Remaining service lifetimes of building components.

This data can be used to assess both current and future sensitivity, enabling different scores to be assigned for different time horizons. Other useful information to assess sensitivity is:

- Asset performance thresholds
- Maintenance records
- Insights from site staff
- Professional judgement of material types

When assessing sensitivity for future scenarios, it may be necessary to apply assumptions. For example, it may be assumed that components will age and deteriorate, be replaced with like-for-like or lower quality materials at the end of their serviceable lifetimes, and that no adaptation measures will be implemented.

Sensitivity can be scored from 1-3 (low, moderate, high) for each asset over each time horizon. Example scoring criteria for sensitivity adapted from IPCC guidance is summarised in Table 2.

Table 2. Example sensitivity scoring criteria, adapted from IPCC guidance, on the climate proofing of infrastructure (IPCC, 2023).

Class	Category	Built Environment / Estate
3	High	Receptor is highly sensitive to a given hazard and / or has a very limited ability to adapt to reduce the impacts of the hazard
2	Moderate	Receptor is moderately sensitive to a given hazard and / or has some ability to adapt to reduce the impacts of the hazard
1	Low	Receptor is largely insensitive to a given hazard and / or has a high ability to adapt to reduce its impacts

To support the identification of sensitivities, a selection of illustrative climate sensitivities are provided below for office-type buildings. Further examples for different building types based on their use are provided in Appendix D. These examples are intended as suggestions only and do not represent an exhaustive list. Actual sensitivities will vary between buildings depending on their age, construction materials, design, insulation levels, ventilation, condition, and other site-specific characteristics. The examples are provided to support initial thinking and should be refined using local knowledge, site inspections, and information gathered during engagement with operational staff.

Office

- **Internal heat gains** e.g. from insufficient or large areas of glazing, high equipment use, high occupancy.
- **Ventilation capacity** e.g. suitability and condition of passive or mechanical ventilation systems.
- **Drainage or rainwater management** e.g. blocked, undersized or damaged gutters or downpipes.
- **Building fabric condition** e.g. roofs, cladding, seals, insulation.
- **Reliance on electrical systems** e.g. HVAC, lighting, ICT.
- **Dependence on well-maintained safety systems** e.g. fire alarms, emergency lighting.
- **External access** e.g. susceptibility of access roads, paths, or car parks to flooding or ice.

Assess building or site criticality

Criticality is assessed by determining *the functional importance of each building or asset to the operation of the site and to NRW's overall service delivery*. Factors to consider include:

- Consequences of service disruption and building closures
- Availability of backup facilities or alternative working arrangements
- Health and safety implications
- Economic impacts

Criticality can typically be assessed consistently across baseline and future time horizons as the consequences if a risk were to occur are similar over time. Information to support this assessment may be gathered from engagement with site staff, facilities managers, and organisational service leads.

Criticality may be scored on a 1-3 scoring system (minor, moderate, critical) for each building or asset. Example scoring criteria for criticality adapted from IPCC guidance is summarised in Table 3. A score of 'critical' (3) may be appropriate where the criteria are generally met. For example, where a climate risk causes prolonged closure of a building and significant repair costs, even if complete structural failure does not occur.

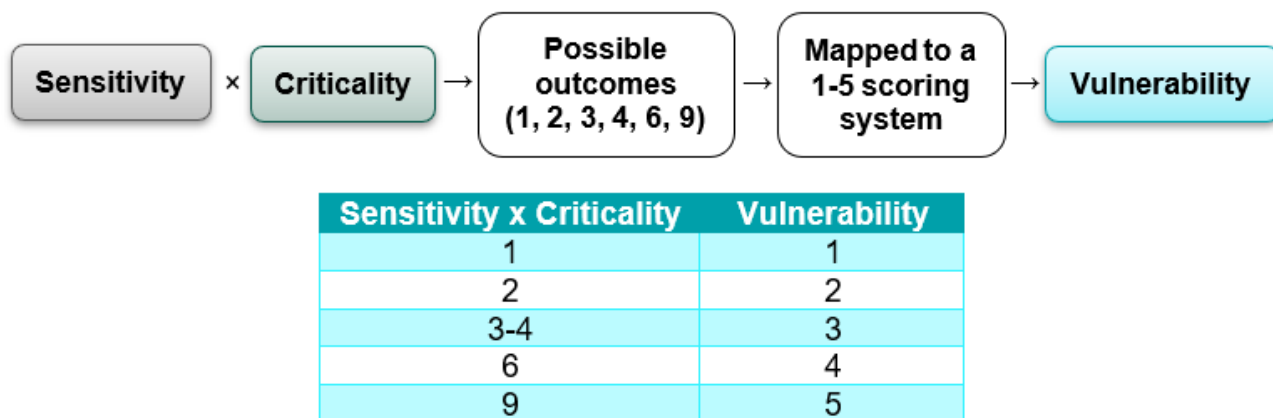
Table 3. Example criticality scoring criteria, adapted from IPCC guidance, on the climate proofing of infrastructure (IPCC, 2023).

Class	Category	General Description	Built Environment / Estate	People (Staff)	Economic
3	Critical	Widespread service failure with services unable to cope with wide-scale impacts	Complete structural failure of the building	Extreme distress and discomfort. Operations halted and prolonged closure of the building	Significant repair, replacement, or operational costs
2	Moderate	Service provision under severe pressure. Appreciable decline in service provision at community level	Noticeable damage to infrastructure affecting service delivery	Noticeable inconvenience and discomfort to staff working conditions. Impact on workforce productivity. Substantial disruption to operations and possible short-term closure of the building	Moderate repair, replacement, or operational costs
1	Minor	Isolated but noticeable examples of service decline	Minor damages that require repairs but do not impact services	Minor inconvenience. Slight discomfort and impact on workforce; manageable with minor adjustments	Minor repair, replacement, or operational costs

Calculate vulnerability score

Vulnerability may be calculated by multiplying the sensitivity and criticality scores. The resulting combined score (ranging from 1-9) should then be mapped onto a 1-5 scoring system to generate the overall vulnerability score for each building to each risk statement over the time periods as summarised in Figure 4. This enables the use of a 1–25 risk scoring matrix in line with NRW’s existing risk methodology and widely used climate risk assessment practices.

Figure 5. Example vulnerability scoring methodology and mapping of multiplied sensitivity and criticality scores to vulnerability on a 1-5 scoring scale.



Assess risk

Steps	Data Needs	Outcomes	Additional Guidance
1. Combine exposure and vulnerability scores	<ul style="list-style-type: none"> Exposure scores Vulnerability scores Defined risk statements 	<ul style="list-style-type: none"> 1-25 risk score 	<ul style="list-style-type: none"> ISO 14091:2021

Purpose of risk scoring

The risk scoring stage brings together the outputs from the exposure and vulnerability assessments to enable consistent comparison of climate risks across the site. Combining these scores provides a clear picture of overall climate risk and supports the prioritisation of actions for the adaptation planning stage.

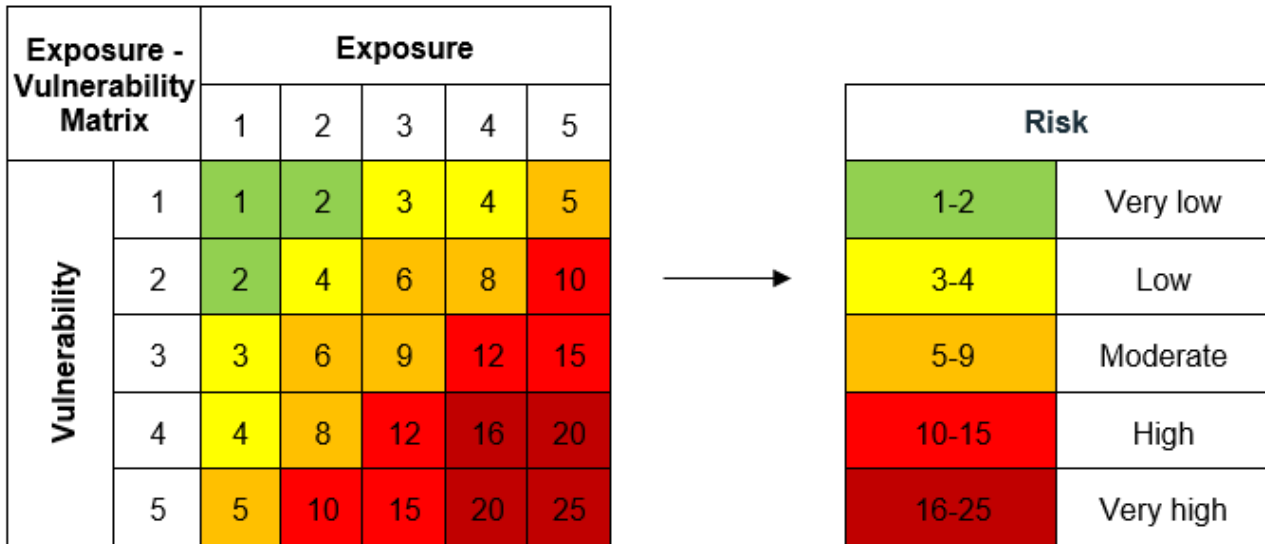
Approach to risk assessment

An overall risk score is assigned to each of the priority risk statements developed during the climate screening stage.

Combine exposure and vulnerability scores

The 1-5 scores assigned to each risk statement in the previous exposure and vulnerability assessment stages are multiplied to provide an overall 1-25 risk score. This score can then be used to categorise the level of risk from very low to very high (see Figure 5).

Figure 6. Example climate risk scoring matrix based on the ISO 14091:2021 assessment of exposure and vulnerability of a climate hazard



An example of how a risk score may be calculated, taken from the CCRA for Resolven, is shown in Figure 6. The scorecard includes 1-5 scores for exposure and vulnerability which, when multiplied, give an overall risk score of 1-25.

Figure 7. Example risk scorecard for risk 4: Shortened service life of building materials from moisture ingress during intense or wind-driven rain. Source: Resolven CCRA

Table 34. Risk scorecard for risk 4 showing results for the Main Office Building, Warehouse, Boiler Room and Deer Larder, including exposure, vulnerability and overall risk scores

Building	Baseline			2030s RCP4.5			2030s RCP8.5			2050s RCP4.5			2050s RCP8.5			2080s RCP4.5			2080s RCP8.5		
	E	V	R	E	V	R	E	V	R	E	V	R	E	V	R	E	V	R	E	V	R
Main Office Building	2	4	8	2	4	8	3	4	12	3	4	12	3	4	12	4	4	16	5	4	20
Warehouse	2	1	2	2	1	2	3	1	3	3	2	6	3	2	6	4	2	8	5	2	10
Boiler Room	2	2	4	2	3	6	3	3	9	3	3	9	3	3	9	4	3	12	5	3	15
Deer Larder	2	1	2	2	1	2	3	1	3	3	2	6	3	2	6	4	2	8	5	2	10

E: Exposure, V: Vulnerability, R: Risk

Green: Very Low Risk, **Yellow:** Low Risk, **Orange:** Moderate Risk, **Red:** High Risk, **Dark Red:** Very High Risk

4. Planning adaptation

Steps	Data Needs	Outcomes	Additional Guidance
<ol style="list-style-type: none">1. Identify level of control over each risk2. Create longlist of adaptation actions3. Prioritise adaptation actions4. Create an implementation plan	<ul style="list-style-type: none">• High level understanding of cost and feasibility of different measures	<ul style="list-style-type: none">• Adaptation actions grouped by ease of implementation• Adaptation implementation plan	<ul style="list-style-type: none">• <u>Climate-ADAPT</u>• <u>UKGBC Climate Adaptation</u>• <u>Adaptation Recommendations for Buildings</u>

Purpose of planning adaptation

Having identified key climate-related risks there is a need to identify the actions required to adapt buildings and estates to better manage these risks. Adaptation measures include:

- Specific building-related interventions e.g. installing blinds to address overheating
- Organisation-wide policies or systems e.g. updating health and safety guidance for hot weather working, or embedding climate risk within processes for making investment decisions.

While some risks will be clearly within the organisation's remit and control (e.g. improving site drainage to deal with heavy rainfall), others, such as the risk of flooding from main rivers, will require strong partnerships with other organisations.

Approach to planning adaptation

This section provides a structured approach to adaptation planning, focussing on first determining the level of organisational control over each risk identified in the climate change risk assessment stage, before identifying and prioritising adaptation actions, and developing a clear, actionable implementation plan.

Identify level of control over each risk

A key initial step in the adaptation process is to identify the level of control that the organisation has over different types of priority risk. Broadly, risks can be split into three different categories (analogous to Scope 1, 2 and 3 emissions in decarbonisation):

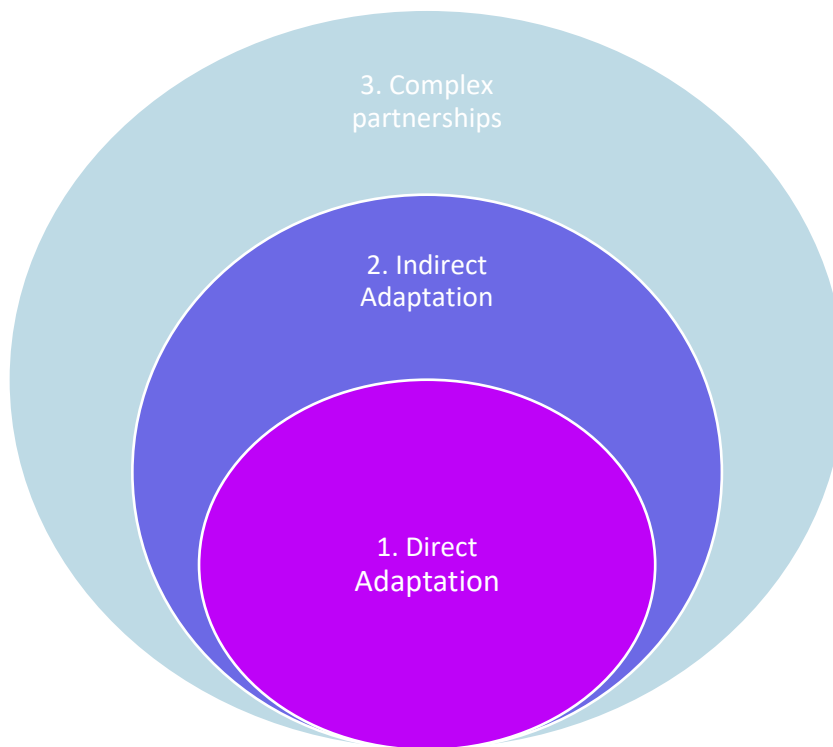
1: Direct adaptation – those over which we have direct control, and can choose to put in place some kind of adaptation without input from other organisations (e.g. overheating of a building where NRW own the site).

2: Indirect adaptation – those where we have indirect influence, but which require decisions from external partners, as well as NRW. For example, we could engage with a

supplier or contractor to improve resilience in our supply chain, or use a relationship with a landowner to improve flood protection. There are levers we can use to influence adaptation, but it is not solely in our control.

3: Complex partnerships – where a risk has been identified but we as an individual organisation have limited ability to influence, or where the adaptation required is at much larger scale. For example, catchment scale action to address flood risk, or resilience of the wider electricity network on which we rely. These actions often require partnerships between multiple stakeholders and are dependent on investment decisions that are outside of our control.

Figure 8. Spheres of influence for adaptation actions



Categorise each of the priority risks identified through the climate change risk assessment according to this framework. After this, identify the internal stakeholders that need to be involved in the process, and the external organisations that NRW would need to engage with where risks fall into levels 2 or 3. This provides important early information about the level of complexity involved in addressing different risks, and begins the process of identifying which stakeholders need to be involved in the adaptation planning process.

Create longlist of adaptation actions

Adaptation includes a wide range of potential activities, incorporating site or building-specific measures (Table 4), organisational strategy and governance, catchment-scale approaches to manage risks from fire or flooding, and operational or behavioural changes. While adaptation measures may be traditional 'hard' infrastructure (upgrades to drainage

networks, or glazing), there is an increasing focus on prioritising nature-based solutions, those adaptation measures that also have benefits for nature recovery.

There are lots of sources of information that can help when compiling a list of potential adaptation actions. We recommend the following key considerations for identifying adaptation actions:

- Discuss the risk being addressed with the relevant site or facilities management team, or buildings surveyor. Their expertise and site-specific knowledge will likely be able to suggest possible adaptation actions.
- Review key sources of data on adaptation of sites and buildings to different hazards. A list of indicative actions is provided in Table 4, and further potential sources of guidance in the references section.
- Discuss possible adaptation actions with the NRW climate risk and adaptation team, to get specialist advice on potential adaptation actions.
- For risks where NRW has limited influence, review planned actions and engage with key stakeholders to understand ongoing and planned adaptation measures from partners.

Table 4. Indicative adaptation actions, to be supplemented by additional data sources.

	Heat	Flood	Wind
Building	Passive cooling strategies Green roofs Blinds and shutters External shading	Raise height of basement equipment Flood pumps Flood resistance measures	Building fabric improvements Check external roof fittings
Site	Additional tree cover Shading Replacing unnecessary concrete and tarmac	SuDS Drainage improvements Improved flood defences or catchment flood management	Review vegetation management plans Wind breaks if appropriate

At the organisational level, for multiple climate hazards, adaptation actions can include:

- Adding climate risks to site and organisational risk registers
- Embedding adaptation into ongoing retrofit and upgrade programmes
- Developing digital tools to enhance climate risk assessment capability

At the operational level, for multiple climate hazards, adaptation actions can include:

- Adjusting maintenance schedules during hot weather
- Reviewing business continuity plans
- Reviewing access to and use of extreme weather warnings and forecasts

Prioritise adaptation actions

The most important factors in prioritising actions are the level of risk and ease of implementation. The risk level is derived from the score given in the climate change risk assessment, and ease of implementation comprises NRW's level of influence on the risk, the complexity of the technical solution, its cost, and the extent to which it can be integrated into existing NRW programmes or processes.

Put simply, the prioritisation process is designed to answer the following questions, which can help to structure an adaptation plan (for a site, asset or department):

What can we do now, with little effort, to improve our resilience? This might include:

- Changes to a health and safety policy
- Adjustments to maintenance regimes
- Opportunities to integrate adaptation actions into ongoing decarbonisation programmes.

What are the actions that are important, but we can't implement yet? This may be because;

- They are higher cost
- They are challenging from a stakeholder complexity point of view
- They are outside the direct control of the organisation?

What are the enabling actions that need to happen to get closer to those actions being possible? For example:

- How do we develop the business case for investments in adaptation?
- What are the wider partnerships that are needed?
- What are the actions that need to happen to build organisational capacity to better manage climate risks?

Formal assessment and ranking of adaptation actions may not be deemed necessary if it is felt that the priority actions to take are clear. If there is a need for further assessment of actions, there are a number of different approaches that can be used, ranging from highly technical decision-support approaches to more simple, structured assessment processes

such as multi-criteria analysis (MCA). The following process facilitates the categorisation and prioritisation of different actions:

Level of Risk

The 5-point risk categorisation (from very low to very high) based on the climate change risk assessment is used to score the level of risk, or urgency, of the adaptation action.

Ease of Implementation

Ease of implementation varies depending on a range of factors. This scoring approach scores the level of influence or control NRW has over the adaptation measure, the complexity of the action to implement, the effectiveness of the action in reducing the risk, and the cost of the action individually on a 1-3 scale (Table 5). These scores are then added to provide an overall score for ease of implementation (Figure 8).

Table 5. Scoring criteria for four components of ease of implementation: level of influence, technical complexity, effectiveness and cost

Score	Level of influence	Technical complexity	Effectiveness	Cost
1	Direct control	Well understood action with clear best practice guidance which can be implemented by in-house NRW staff	Fully – the adaptation action is expected to fully address the identified risk	Low – measure is low cost and can broadly be covered from existing budgets
2	Indirect control	Well understood action, but expertise for implementation is not available in-house and would therefore require external contractors	Partially – the adaptation action will help to reduce the risk but will need to be carried out in combination with other actions to fully address the risk	Medium – the adaptation action would require reallocation of resources but does not represent significant additional investment
3	Complex partnerships	Technically challenging action either due to scale or innovation. Few examples where it has been implemented and would require external contractors	Limited – the adaptation action is expected to have a relatively small impact on the risk	High – the adaptation action would require significant additional funding, either from external sources or requiring approval as part of a multi-year budget

Figure 9. Overall scoring categories for ease of implementation

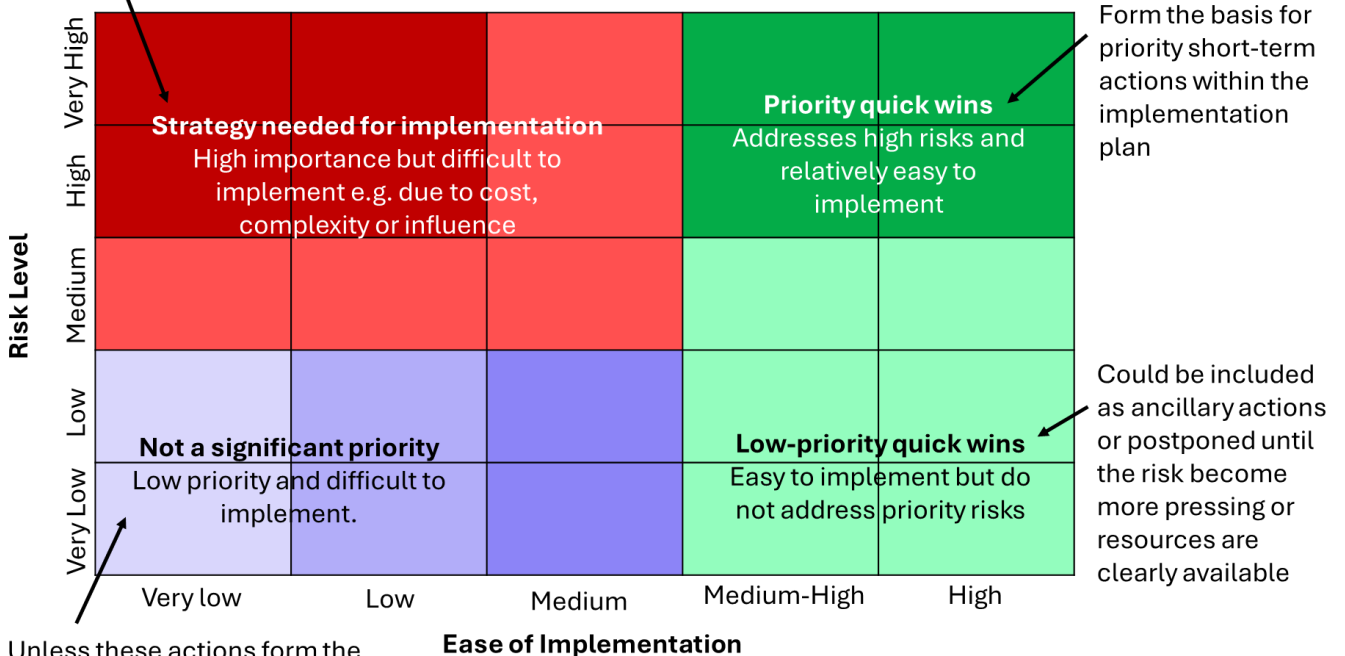
Ease	Score
High	4-5
Medium-High	6-7
Medium	8-9
Low	10-11
Very low	12

Create an implementation plan

Combining the scores for urgency and ease of implementation enables the identification of different types of adaptation priority, as shown in Figure 9. This can be used as the basis for structuring an implementation plan for adaptation. An implementation strategy, whether at the site or organisational level, should consider the timing and phasing of different actions, the actions needed to improve the enabling conditions for adaptation, and entry points for adaptation within existing organisational programmes or policies.

Figure 10. Prioritisation matrix for adaptation actions

Identify measures required to facilitate future implementation, e.g. by working through partnerships to get agreement on actions over which NRW have little direct control, or developing a longer-term funding strategy or business case for larger-scale investments.



Unless these actions form the foundations of future actions or can be tied into existing programmes or sources of funding, they are not a priority for implementation.

Partnerships and Integration

A key part of the implementation strategy is identifying the existing or planned programmes of work which could act as entry points for the adaptation actions. Many heat resilience measures can be incorporated into ongoing Net Zero retrofit schemes, while there may also be an opportunity to include the simpler actions within planned site or building maintenance and upgrades, or updates to health and safety policies, for example.

Partnerships, whether with landowners, local authorities, utilities, or national government, can be an essential part of adaptation. Partnerships may also be needed between internal teams, depending on capacity, resources, and responsibilities. For risks where NRW has only indirect or limited control, engagement with partners is an essential part of any adaptation strategy. With suppliers this could include asking simple questions about what measures the supplier has in place to manage climate-related disruption. For risks and adaptation measures where multiple stakeholders are required, NRW can seek to use its convening power to begin discussions on how risks can be effectively managed, and what the barriers to adaptation are.

5. Adaptation monitoring

Steps	Data Needs	Outcomes	Additional Guidance
<ol style="list-style-type: none">1. Identify the outcomes that are to be measured2. Identify indicators that are relevant to these outcomes3. Review monitoring results and refine approach	<ul style="list-style-type: none">• Data to inform the development of indicators	<ul style="list-style-type: none">• The impact of your adaptation actions is understood• Established systems to collect data	<ul style="list-style-type: none">• <u>ISO 14090:2019</u>

Purpose of adaptation monitoring

Evaluating the impact of any adaptation options that are implemented will help to identify which are the most effective. This is a critical step in determining whether the interventions that have been introduced are having their intended impact, or whether additional actions are necessary to reduce the impacts of the risks that have been observed. For example, determining whether the measures that have been introduced to reduce the likelihood of flooding at a site have been successful.

Approach to adaptation monitoring

To monitor the effectiveness of adaptation interventions, it is necessary to identify the outcomes that are to be measured and to identify the indicators which provide insight into whether those outcomes have been delivered. The indicators selected should ideally be aligned to information already collected for the site. This will help integrate this monitoring into the routine management of the site.

Identify the outcomes that are to be measured

Defining the outcomes anticipated from the adaptation measures that have been introduced is critical to informing your approach to monitoring effectiveness. These outcomes will likely be strongly related to the key climate risks you are aiming to manage. For example, if the risks of flooding to a site has led to the introduction of an adaptation measure, then the outcome(s) you are seeking to track will be related to this. Example outcomes could include:

- Flooding: There is a reduction in the incidence of flooding on site
- Heat: Improving the thermal efficiency of a building reduces cooling requirements during summer

Identify indicators that are relevant to these outcomes

Identifying indicators that are relevant to the outcomes that are of interest for monitoring will help to track the effectiveness of measures that have been introduced. When selecting relevant indicators, choosing ones where the data is already regularly collected can ease the monitoring burden. Example indicators could include:

- Flooding: Number of hours / days that building access / operations are restricted due to flooding
- Flooding: Number of internal water ingress incidents
- Heat: The amount of time where indoor temperatures stayed within a desired range (e.g., between 18°C and 25°C).
- Heat: The number of days where indoor temperatures exceed an agreed threshold (e.g., greater than 25°C.)

When the indicators are selected, it is important to establish a baseline against which change will be measured. This will help show the overall impact of the action that has been implemented. Finally, once the indicators have been chosen, it is important to determine how the data that will inform the indicator will be collected. If this is new data that has not been collected previously it might be useful to align the data collection regime to coincide with when the climate risk may occur (e.g., surveying the number of internal water ingress incidents after the wettest months of the year).

Review monitoring results and refine approach

Reviewing the results of the indicators will help to show whether the adaptation actions are having their intended effect. This will help determine whether additional action is required. It may also be useful to reevaluate the key climate risks periodically to determine if the newly introduced measures continue to be successful and whether any modifications are necessary.

References

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- Met Office (2024) [Local Authority Climate Service](#)
- Met Office (2019) [Extreme Value Analysis](#)
- Met Office (2018) [UKCP18 Guidance: Representative Concentration Pathways](#)
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- UK Centre for Ecology & Hydrology (2025) [Flood Estimation Handbook \(FEH\)](#)
- UK Climate Resilience Programme (2023) [Climate Risk Indicator Explorer](#)
- UK Green Building Council (2022) [A Framework for Measuring and Reporting of Climate-related Physical Risks to Built Assets](#)

Appendices

Appendix A. Glossary

Adaptation to climate change: Process of adjustment to actual or expected climate and its effects.

Adaptive capacity: Ability of systems, institutions, humans, and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences.

Decision-making: The process of identifying the likely consequences of decisions, establishing the importance of individual factors and selecting the best course of action to take to manage an environmental risk.

Exposure: Presence of people, livelihoods, species or ecosystems, environmental functions, services, resources, infrastructure, or economic, social or cultural assets in places and settings that could be affected.

Hazard: A situation or biological, chemical or physical agent that may lead to harm or cause adverse effects. In the context of climate change any climate or hydrological event or slower change over time that causes negative impacts or presents opportunities.

Interdependencies: These are connections within and between systems that may result in risks to people, property or operations due to failure in an external system or supply chain.

Physical Climate Risk: A risk associated with natural climate variability or future climate change.

Representative Concentration Pathways (RCPs): 21st century pathways of greenhouse gas emissions used within climate change assessments. The RCPs represent the range of future potential scenarios of greenhouse gas emissions and are used to model and understand a broad range of potential climate outcomes in the future.

Risk: The potential for a climate-related hazard to cause harm to assets, operations or people. It reflects the combined effect of exposure to the hazard and the vulnerability of the asset, operations or people to its impacts.

Risk management: The process of appraising options for responding to risk and deciding which to implement. In the context of climate change, options are climate adaptation or climate mitigation measures.

Sensitivity: The sensitivity of people, operations or assets to changing climate variables or climate hazards.

Shared Socioeconomic Pathways (SSPs): Pathways that incorporate climate and socioeconomic factors to outline a range of plausible future scenarios.

Stakeholders: Individuals who are interested in, or affected by, an issue or situation. These include employees, clients, supply chain and other organisations.

Uncertainty: Limitations in knowledge about environmental impacts and the factors that influence them. Uncertainty originates from randomness (aleatory uncertainty) and incomplete knowledge (epistemic uncertainty).

Vulnerability: Propensity or predisposition to be adversely affected.

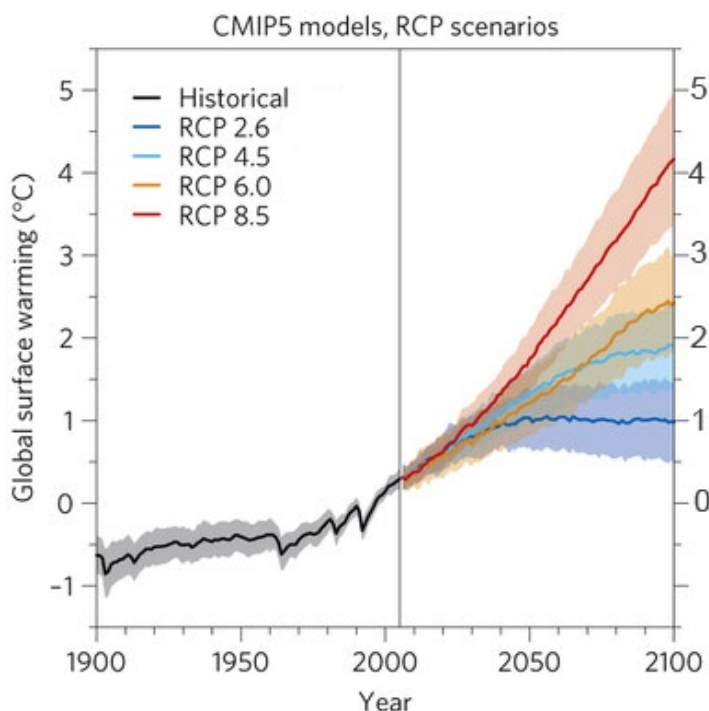
Appendix B. Representative Concentration Pathways (RCPs)

Representative Concentration Pathways (RCPs) describe 21st century pathways of greenhouse gas emissions and are used within climate change assessments (IPCC, 2019). The RCPs represent the range of future potential scenarios of greenhouse gas emissions and are used to model and understand a broad range of potential climate outcomes in the future (Met Office, 2018). Two RCPs are referenced in this document:

- **RCP4.5** – a moderate greenhouse gas emissions scenario considered an ‘intermediate’ scenario. Global surface temperature is projected to be 2.4°C higher in 2081-2100 compared to the pre-industrial period (1850-1900).
- **RCP8.5** – a high greenhouse gas emissions scenario considered a ‘worst case’ scenario where greenhouse gas emissions continue to increase unmitigated. Global surface temperature is projected to be 4.3°C higher in 2081-2100 compared to the pre-industrial period (1850-1900).

Both scenarios are consistent with increases in global mean temperature by 2100 of around 2°C and 4°C degrees above pre-industrial levels (see Figure 10). It should be noted that all climate model projections have inherent uncertainty. RCPs are defined as pathways therefore are not definitive, with alternative future scenarios potentially occurring in reality.

Figure 11. Projected global temperature change showing RCP scenarios (1900–2100). Historical trend (black) and future warming projections: RCP2.6 (blue), RCP4.5 (light blue), RCP6.0 (orange), RCP8.5 (red). Shaded areas show uncertainty ranges.



Appendix C. Example Risk Statements

To support the development of risk statements, a selection of illustrative examples is provided below for different building types based on their use. The examples are not exhaustive but show how a risk statement can be developed by collating information on the hazard and impact or consequence.

Office

- **Hazard:** High temperatures → **Impact:** overheating → **Consequence:** heat stress to building structures, fixtures and fittings → **Risk Statement:** high temperatures leading to overheating and causing heat stress to building structures, fixtures and fittings with potential for reduced service life and increased maintenance requirements
- **Hazard:** Heavy rainfall → **Impact:** water ingress → **Consequence:** shortened service life of building materials → **Risk Statement:** heavy rainfall leading to water ingress and shortened service life of building materials and increased maintenance requirements
- **Hazard:** Storms and high winds → **Impact:** power outages → **Consequence:** disruption to ICT or electrical supply → **Risk Statement:** storms and high winds leading to power outages and causing disruption to ICT or electrical supply with associated disruption to operations
- **Hazard:** Surface water flooding → **Impact:** flooding of access road → **Consequence:** restricted site access → **Risk Statement:** surface water flooding leading to flooding of access road and causing restricted site access and potential disruption to operations

Depot

- **Hazard:** Surface water flooding → **Impact:** yard flooding → **Consequence:** damage to stored materials and equipment → **Risk Statement:** surface water flooding leading to yard flooding and causing damage to stored materials and equipment resulting in potential disruption to operations
- **Hazard:** Heatwave → **Impact:** equipment overheating → **Consequence:** disruption to operations → **Risk Statement:** heatwave conditions leading to overheating of equipment resulting in equipment malfunction and potential for disruption to operations
- **Hazard:** Storms → **Impact:** damage to roller shutters → **Consequence:** asset loss or repair costs → **Risk Statement:** storm event resulting in damage to roller shutters and causing loss or damage to assets with associated repair or replacement costs

Workshop

- **Hazard:** Heatwave → **Impact:** safe working temperatures exceeded → **Consequence:** health and safety issues and reduced productivity → **Risk Statement:** heatwave conditions leading to safe working temperature thresholds being exceeded causing health and safety risks to staff and reductions in productivity
- **Hazard:** Storms → **Impact:** damage to lightweight roofs → **Consequence:** repair costs → **Risk Statement:** storm events causing damage to lightweight roof structures resulting in repair costs
- **Hazard:** Flooding → **Impact:** inundation → **Consequence:** equipment damage → **Risk Statement:** flooding leading to inundation of workshop areas causing damage to equipment and tools resulting in repair costs and operational disruption

Visitor Centre

- **Hazard:** Heatwave → **Impact:** overheating → **Consequence:** staff and visitor health and safety issues, temporary closure or reduced footfall → **Risk Statement:** heatwave conditions leading to overheating and resulting in staff and visitor health and safety concerns with potential for closure or reduced footfall and associated financial losses
- **Hazard:** Flooding → **Impact:** access disruption → **Consequence:** temporary closure or reduced footfall → **Risk Statement:** flooding leading to disruption to access routes resulting in potential for closure or reduced footfall and associated financial losses
- **Hazard:** Storms → **Impact:** damage to sensitive structures → **Consequence:** repair cost → **Risk Statement:** storm events causing damage to sensitive structures leading to repair costs

Unoccupied Building

- **Hazard:** Heavy rainfall → **Impact:** water ingress and fabric deterioration → **Consequence:** repair costs → **Risk Statement:** heavy rainfall leading to water ingress causing deterioration of building fabric resulting in increased maintenance and repair costs

Toilet Block

- **Hazard:** Drought → **Impact:** water scarcity → **Consequence:** facility closure → **Risk Statement:** drought conditions leading to water scarcity resulting in closure of toilet facilities and potential reputational impacts
- **Hazard:** High humidity → **Impact:** mould → **Consequence:** health and safety risks → **Risk Statement:** high humidity leading to mould growth causing health and safety risks
- **Hazard:** Storms → **Impact:** damage to lightweight structures → **Consequence:** repair costs and service disruption → **Risk Statement:** storm events causing damage to lightweight structures resulting in repair costs and service disruption

Reserve Base (e.g. wildlife, marine)

- **Hazard:** Storm → **Impact:** building and infrastructure damage → **Consequence:** repair costs and disruption to operations → **Risk Statement:** storm events causing damage to buildings and infrastructure resulting in increased repair costs and disruption to operations
- **Hazard:** Heatwave → **Impact:** overheating → **Consequence:** animal welfare concerns → **Risk Statement:** heatwave events leading to overheating of facilities resulting in animal welfare concerns
- **Hazard:** Flooding → **Impact:** disruption to access routes e.g. slipways → **Consequence:** disruption to operations → **Risk Statement:** flooding leading to disruption to access routes resulting in delays to operations

Other (e.g. Deer Larder, Boat House, Hatchery, Storage, Laboratory, Dipping Shed, Pesticide Stores)

- **Hazard:** Heatwave → **Impact:** refrigeration failure → **Consequence:** spoilage of stored materials → **Risk Statement:** heatwave conditions leading to refrigeration failure causing spoilage of stored materials

- **Hazard:** Water scarcity → **Impact:** disruption to water supply → **Consequence:** hatchery or laboratory failure → **Risk Statement:** water scarcity event leading to disruption to water supply resulting in failure of hatchery or laboratory operations
- **Hazard:** Storm → **Impact:** power outage → **Consequence:** critical equipment shutdown and disruption to operations → **Risk Statement:** storm events leading to power outages causing shutdown of critical equipment and disruption to operations

Appendix D. Example Vulnerabilities

To support the identification of vulnerabilities, a selection of illustrative climate vulnerabilities are provided below for different building types based on their use. These examples are intended as suggestions only and do not represent an exhaustive list. Actual vulnerabilities will vary between buildings depending on their age, construction materials, design, insulation levels, ventilation, condition, and other site-specific characteristics. The examples are provided to support initial thinking and should be refined using local knowledge, site inspections, and information gathered during engagement with operational staff.

Office

- **Internal heat gains** e.g. from insufficient or large areas of glazing, high equipment use, high occupancy.
- **Ventilation capacity** e.g. suitability and condition of passive or mechanical ventilation systems.
- **Drainage or rainwater management** e.g. blocked, undersized or damaged gutters or downpipes.
- **Building fabric condition** e.g. roofs, cladding, seals, insulation.
- **Reliance on electrical systems** e.g. HVAC, lighting, ICT.
- **Dependence on well-maintained safety systems** e.g. fire alarms, emergency lighting.
- **External access** e.g. susceptibility of access roads, paths, or car parks to flooding or ice.

Depot

- **Exposure of external yards or partially sheltered structures** e.g. to intense rainfall, extreme heat or high winds.
- **Storage of goods or equipment** e.g. in areas potentially sensitive to heat, wind or surface water flooding.
- **Suitability of ventilation or insulation** e.g. impacting thermal comfort of staff.
- **External access** e.g. susceptibility of access roads, paths, or car parks.
- **Reliance on equipment for operational continuity** e.g. pumps, compressors.
- **Building fabric condition** e.g. roofs, cladding, seals, roller shutters.

Workshop

- **Manual working conditions** e.g. where machinery or processes generate internal heat gains.
- **Suitability of ventilation or insulation** e.g. impacting thermal comfort of staff.
- **Sensitivity of tools, machinery or stored materials** e.g. to high temperatures and humidity.
- **Reliance on electrical systems** e.g. HVAC, lighting, ICT.
- **Building materials** e.g. older or lightweight envelopes.
- **Entryway heights** e.g. increasing susceptibility to surface water flooding.

Visitor Centre

- **Internal heat gains** e.g. from insufficient or large areas of glazing, high levels of occupancy.
- **Public comfort and safety requirements** e.g. for heating, cooling and ventilation.
- **External access routes** e.g. susceptibility of access roads, paths, or car parks.
- **Historic or architecturally sensitive structures** e.g. may have poor insulation, ageing materials or limited adaptive capacity.
- **Exposure of external areas** e.g. boardwalks, outdoor seating.
- **Reliance on electrical systems** e.g. for ticketing, security and visitor operations.

Unoccupied Building

- **Poor ventilation** e.g. leading to mould, damp and humidity-related damage.
- **Limited monitoring and occupancy** e.g. increased likelihood of unnoticed deterioration or damage.

Toilet Block

- **Reliance on water supply** e.g. making facilities vulnerable to water scarcity or drought.
- **Drainage and wastewater** e.g. potential for overwhelm during heavy rainfall, pipe burst during cold periods.
- **Ventilation capacity** e.g. affecting humidity control.
- **Building materials** e.g. lightweight building envelope vulnerable to storms.

Reserve Base (e.g. wildlife, marine)

- **Sensitivity of specialised equipment** e.g. to high temperatures and humidity.
- **Outdoor working conditions** e.g. sensitivity to heat, wind, rain and extreme weather.
- **External access routes** e.g. susceptibility of access roads, tracks, slipways.
- **Storage of goods or equipment** e.g. requirements for specific environmental conditions.
- **Building location** e.g. sensitivity to storms, coastal erosion, coastal flooding.

Other (e.g. Deer Larder, Boat House, Hatchery, Storage, Laboratory, Dipping Shed, Pesticide Stores)

- **Reliance on electrical systems** e.g. HVAC, lighting, refrigeration, specialist equipment.
- **Storage of chemicals, biological materials or equipment** e.g. requirements for specific environmental conditions.
- **Sensitivity of specialised equipment** e.g. to high temperatures and humidity
- **Ventilation capacity** e.g. suitability and condition of passive or mechanical ventilation systems.
- **Reliance on water supply** e.g. for hatcheries, laboratories, cleaning processes.
- **Building location** e.g. exposure to storms, coastal erosion, coastal flooding.
- **Entryway thresholds** e.g. increasing susceptibility to flooding.
- **Building fabric condition** e.g. roofs, cladding, seals, insulation.
- **Limited monitoring and occupancy** e.g. increased likelihood of unnoticed damage.

Data Archive Appendix

No data outputs were produced as part of this project.

The data archive contains:

[A] The final report in Microsoft Word and Adobe PDF formats.

Metadata for this project is publicly accessible through Natural Resources Wales' Data Discovery Service <https://metadata.naturalresources.wales/geonetwork/srv> (English version) and <https://metadata.cyfoethnaturiol.cymru/geonetwork/cym/> (Welsh Version). The metadata is held as record no [NRW to insert this number].

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