Environment Agency

Flood risk asset maintenance and inspection: good practice guidance

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Introduction to asset maintenance

Applying this guidance

This guidance is for England only.

In England, the Flood and Water Management Act 2010 delegates responsibility for managing flood and coastal erosion risk to risk management authorities (RMA's).

All powers relating to flooding and land drainage are permissive. This means the RMAs have discretionary powers to manage flood risk. However, they are not required to take action when there is a flood.

The RMAs are:

- Environment Agency
- lead local flood authorities (LLFAs)
- district councils
- coastal erosion risk management authorities
- internal drainage boards (IDBs)
- highways authorities
- water companies

Environment Agency

The Environment Agency has a strategic overview for all sources of flooding and coastal erosion. We work with other organisations to manage flooding and erosion risks. We do this for:

- main rivers
- the sea
- reservoirs

Lead local flood authorities (LLFAs)

These authorities have the lead operational role in managing surface water and groundwater flooding. In areas without district councils, they also manage flood risk from non-main rivers.

District councils

District councils play a role in local flood risk management, especially in areas with no lead local flood authority.

Internal drainage boards (IDBs)

IDBs manage water levels in specific drainage districts. They contribute to flood risk management within their designated areas.

Highway authorities

Highway authorities are responsible for providing and managing highway drainage. They include Highways England and unitary or county councils.

Water and sewerage companies

These companies are responsible for managing the risks of flooding from surface water and foul or combined sewer systems.

Coastal erosion risk management authorities

These are organisations responsible for overseeing and addressing the risks associated with coastal erosion.

Regional flood and coastal committees (RFCCs)

RFCCs are not RMAs. However, they provide strategic oversight and coordination for flood, coastal and erosion risk management (FCERM) activities at the local level. They bring together local stakeholders to address flood and coastal risks.

Purpose of this guidance

Proper maintenance and inspection of flood and coastal erosion related assets:

- reduces flood risk
- safeguards lives
- minimises economic damage

This guidance explains good practices for both asset maintenance and inspection. It is based on feedback from:

- RMAs in England
- industry standards
- research

Many RMA flood risk maintenance programmes exceed these standards.

Factors influencing maintenance

There are 6 factors you should consider that influence maintenance. These are:

- weather
- growing season
- legislative requirements
- local priorities
- access issues
- working with the environment

This section explains these in more detail.

Weather

Extreme weather includes:

- storms
- floods
- prolonged dry weather

Extreme weather:

- significantly impacts the frequency of asset maintenance
- disrupts scheduled maintenance activities
- accelerates wear and tear on assets, meaning they need more frequent maintenance

You must adapt your maintenance plans to account for weather variability.

Growing season

Weather, influenced by climate change, has a significant impact on vegetation growth and the timing of growing seasons.

Factors that affect this include:

- temperature
- frost days
- rainfall
- prolonged dry weather
- daylight hours

You should regularly review and adjust your maintenance frequencies to account for these changes.

Legislative requirements

Legislative requirements can significantly impact asset maintenance and inspections. Laws and regulations mandate specific maintenance practices. This is done for 3 reasons:

- safety
- environmental protection
- public health

Regular inspections make sure you are compliant with legal standards. You should keep maintenance records to show this compliance.

Overall, legislative mandates shape asset maintenance practices. This can affect:

- allocation and competency requirements of resources
- frequency of maintenance activities or inspections
- documentation required to carry out activities
- the need to retain records to demonstrate overall compliance

Local priorities

We don't always carry out asset maintenance because of a technical need or standards. It can be influenced by:

- local choices
- societal values
- available resources, including funding

We work with stakeholders so that maintenance activities and frequencies reflect community goals. When assessing these changes, you should always consider:

- available funding
- resources
- the impact on the overall asset's performance

Access issues

Access issues can impact asset maintenance. Limited access delays maintenance tasks, especially in remote or poorly accessible locations. Safety risks arise when maintenance personnel face inadequate access conditions.

You must allocate resources, including personnel, tools, equipment properly to account for access constraints.

Efficient access routes are crucial for:

- effective asset maintenance
- minimising downtime
- ensuring safety and compliance

Factors influencing maintenance (continued)

Working with the environment

You must consider several environmental factors to make sure your asset maintenance is effective. These include:

- bird nesting - which impacts the time of maintenance
- protected species - which require special attention due to legal restrictions and to protect their habitat and existence
- Biosecurity measures- which prevent the spread of disease
- pollution control – which is crucial when maintaining assets in, on or near waterbodies

Risk	Considerations
Protected Species	You should consider the impact of maintenance activities on protected species, flora and fauns before you start work on an asset and during on-site works. Examples of protected species include: • great crested newts • bats • water voles • badgers • white clawed crayfish You should consider whether the assets you are maintaining are within or impacts upon: • tree preservation orders • protected habitats – for example sites of special scientific interest (SSSIs) or, special areas of conservation (SACs)
Nesting or over-wintering birds	Plan maintenance activities to minimise disturbing nesting or over-wintering birds.
Biosecurity	You should consider potential biosecurity precautions when planning and delivering maintenance activities. This includes any disease notifications for the area.
Pollution or Contamination	You should consider the impact of maintenance activities to the local environment during the planning phase. Make sure you put in place preventative pollution control measures during the works.

Applicability of maintenance to asset categories

You must align maintenance actions to asset categories. This makes sure your asset management is efficient and effective.

You should tailor maintenance strategies to specific asset types, so you can optimise resource allocation and reduce costs. Prioritising critical assets minimises risks and makes sure you comply with regulations. Data-driven decisions benefit from accurate information on asset classes.

Table 2 sets out the most common asset categories managed by RMAs. We have aligned them to the high-level maintenance and inspections standards. This will help make these activities consistent and transparent.

Asset Category	**Definition**
Aids to navigation	Assets that are used to aid navigation in the marine and fluvial environment.
Amenities	Assets that contribute to the accessibility or usability of a location.
Asset Complex	A grouping of individual assets that can be considered as parts of a single site or complex with a high-level purpose.
Beach structure	Assets used to protect the coast from erosion.
Buildings and compounds	Assets that are used to provide shelter for equipment, storage, or personnel.
Channel	Assets that convey water.
Channel crossing	Assets that allow access across a channel.
Defence	Asset that provides flood defence or coastal protection functions. These include both man-made and natural defences. Natural defences may include man-made elements to make them more effective or protect them from erosion.
Drainage system	A group of drainage assets that are directly or indirectly connected to each other and flow from a source to a common outfall for carrying off excess water. Interconnecting systems sourced from multiple sources can be sub divided into sub systems. Multiple systems can be part of a catchment.
Instruments	Assets used to measure water level and flow.
Land	Areas of land that are involved in water management.
Mechanical, electrical, instrumentation, control and automation (MEICA)	Mechanical, electrical, instrumentation, control and automation assets.
Structure	Assets used to enable, restrict or affect the movement of water, people, fish, animals or materials.

Debris removal

Removing large debris from flood assets is essential because it:

- prevents blockages
- protects infrastructure
- supports efficient conveyance
- controls pollution

Preventing blockages

Some flood defence assets help prevent debris from blocking water flow. These include:

- screens
- sustainable urban drainage systems (SUDS)

When debris accumulates, it can obstruct channels, culverts, and other structures. This can increase the likelihood and severity of flooding.

Protecting infrastructure

Debris can damage infrastructure, including:

- bridges
- culverts
- other water management systems

By removing debris promptly, we safeguard these assets and maintain their effectiveness.

Efficient conveyance

Removing large debris in channels and culverts, that obstructs the normal flow, can help prevent localised flooding. It also helps maintain navigation.

Pollution control

Assets such as SUDS often offer additional benefits. For example they:

- help to improve water quality from storm water runoff
- Improve biodiversity

Removing large or contaminated debris makes sure they can continue to do this.

Debris removal (continued)

Applicable asset categories

You should carry out debris removal on the following assets:

- asset complex
- channel
- drainage system
- land
- structure

Good practice standards

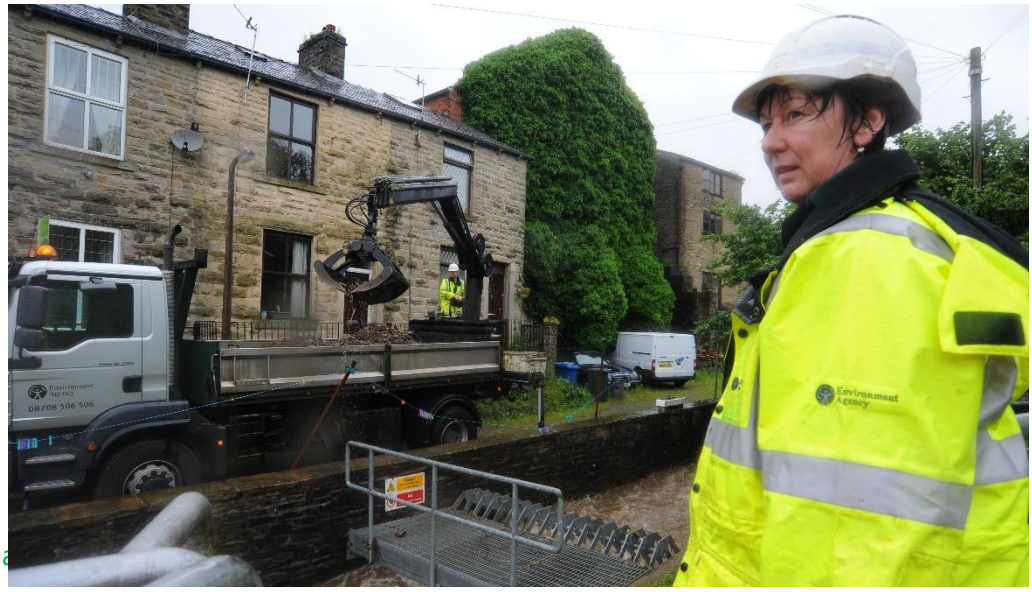
You should:

- ✓ assess debris for its flood risk potential when reported.
- ✓ carry out regular checks and removal of debris from high-risk watercourses every 6 to 12 months.
- ✓ check and clear screens based on local priorities, using the following guidelines:
  - high priority - every 1 to 2 weeks
  - medium priority - every 2 to 4 weeks
  - low priority - every 1 to 3 months
- ✓ consider deploying technology assisted monitoring – for example CCTV, telemetry, and sensors which allow you to efficiently monitor screens and target effort during heavy rain and flood events.

Environmental considerations

You should:

- ✓ be mindful of sensitive areas and seek specialist advice.
- ✓ consider the impact on both the access and watercourse – you should establish sediment traps or pollution booms if needed to mitigate impacts.
- ✓ consider the impact to the local community when planning the works – this includes road and footpath closures and the timing of works.
- ✓ Make sure waste exemptions and licenses are in place to deal with the disposal of the debris.



Grass cutting

Grass cutting on flood assets is very important because it helps to maintain their effectiveness. It helps with:

- erosion resistance and stability
- early detection of defects and inspection

Erosion resistance and stability

Regular grass cutting helps create dense grass sods on the embankments. These sods form a consistent root network. This makes the banks more resilient to erosion caused by:

- waves
- overtopping
- heavy rain

The grass sward protects the earth embankment underneath from external erosion due to:

- rainfall
- wind
- currents
- wave action
- vehicular, pedestrian, and animal traffic

Regular grass cutting also reduces the risk of broad leaf plants such as shrubs and trees establishing. This stops their root systems damaging the assets.

Early detection of defects and inspection

Keeping the grass short allows maintenance teams to monitor the embankments for defects and carry out visual inspections. This lets them quickly detect issues such as burrowing animals that could be hidden in longer vegetation.

Typical methods

Grass cutting is typically carried out by using either:

- a mechanical plant fitted with a flail
- by hand
- by remote controlled mowers – where slopes are steep or unsuitable for larger plant

Grass cutting (continued)

Applicable asset categories

You should carry out grass cutting on the following assets:

- amenities
- asset complex
- buildings and compounds
- channel
- defence
- drainage system
- instruments
- land

Good practice standards

You should:

- ✓ Cut grass once a year on all raised defences - this is a minimum standard, time this to coincide with a visual inspection shortly after.
- ✓ Maintain grass on flood defences to between a height of 5 cm and 10 cm – this means grass cutting occurs 2 to 3 times a year, depending on the weather conditions, growing season and land use.
- ✓ Walk over and check the area prior to mowing – this helps preventing flying debris from damaging machinery and reducing risks to operatives.
- ✓ Don't cut grass more frequently than 3 times a year unless you need to meet legislative requirements. Doing so can be detrimental to the grass sward.

Environmental considerations

You should carry out consultation before you start grass cutting to minimise the environmental impact. You should:

- ✓ avoid bird nesting season – if this is not possible, you should walk over the areas to be mown before work starts.
- ✓ consider leaving less important areas of grass (away from the asset) to establish naturally
- ✓ consider planting pollinators.

Weed and invasive plant control

Controlling weeds and invasive plants is important because it helps:

- maintain water flow
- improve wildlife habitat and biodiversity
- make maintenance easier

Maintaining water flow

Weeds can obstruct watercourses which slows down the flow of water. By removing them, we can improve conveyance and channel capacity. This reduces the risk of localised flooding.
Invasive species can outcompete native plants and clog waterways, leading to increased flood risk. Invasive species include:

- Pennywort
- Parrotsfeather
- Water Fern

During periods of intense flow, these weeds can become mobile. This increases the risk of blocking structures, such as screens, further increasing the likelihood and severity of flooding.

Wildlife habitat and biodiversity

Native aquatic plants provide essential habitats for various wildlife, including:

- fish
- insects
- birds

By removing invasive species, we protect these habitats and maintain biodiversity.

Ease of maintenance

Removing dense vegetation allows better access for maintenance activities. People and machinery can navigate the watercourses more effectively. This makes it easier to inspect and report blockages and other defects.

Typical methods

There are two main methods used for weed and invasive plant control:

- mechanical or manual control – this is physically removing weeds by cutting using machinery
- chemical control – this is using herbicides or other chemicals to target and remove the weed and can include in-channel spraying

Weed and invasive plant control (continued)

Applicable asset categories

You should carry out weed and invasive species control on the following asset categories:

- asset complex
- buildings and compounds
- channel
- defence
- drainage system
- instruments
- land
- structure

Good practice standards

- ✓ You usually only need to cut in- channel weed once a year. However, if the water is navigable you may need to increase the frequency. This is because weed growth can be influenced by water temperature and nutrient levels in the watercourse.
- ✓ For invasive plant control, the frequency will depend on the method used. If you are using herbicide you should:
  - follow the manufacturers recommendations
  - get the necessary approvals.
  - Minimise application to prevent excessive dieback of surrounding grassed areas and maintain asset performance.

Environmental considerations

It is important that you consult with a biodiversity specialist or ecologist before you start weed control work. This will make sure you minimise the environmental impact.

You should considered:

- ✓ leaving a margin of vegetation along the river banks for wildlife.
- ✓ carrying out control work after June to avoid impacting fish spawning season.
- ✓ measuring the water temperature and dissolved oxygen levels before, during and after the weed control – this will make sure conditions don't deteriorate.
- ✓ You must obtain the necessary approvals for both the use of the herbicide and the disposal of the plant material. The Environment Agency usually provides these approvals
- ✓ You can find out more about invasive non-native plants on the non-native species secretariat (NNSS) website.

Weed and invasive plant control (continued)

Typical timings of weed control operations

Table 3 shows when you should normally carry out weed control operations.

Time	Target Weeds	Technique
April to early May	Submerged weeds and algae	Dichlobenil and Terbutryn
May to July	Water crowfoot	First cut
Late May to June	Submerged weeds	Diquat or diquat alginate
Late May to June	Common reed	Glyphosate
Late May to July	Free-floating weeds	Diquat or glyphosate
July to August	Emerging, floating, submerged and algae	Cutting/raking
July to August	Waterlilies	Glyphosate
August to early September	Emerging weeds	Glyphosate
September to October	Water crowfoot	Autumn cut
September to December	Emerging weeds	Channel cleaning/cutting

Tree and vegetation management

Vegetation management includes controlling:

- trees
- branches
- bushes
- weeds
- vines

It is important because each of these types of vegetation can pose a threat to flood risk assets. However, you should also consider their environmental benefits – for example the habitat they provide and woody debris.

Protecting infrastructure

Trees and vegetation can damage infrastructure through their root structures, They also cause damage during storm events when:

- falling limbs can damage structures
- overturned trees can expose flood risk infrastructure to washout and erosion

We can safeguard our assets and make sure they remain effective by managing vegetation proactively.

Efficient conveyance

Removing overhanging vegetation and branches that obstruct the normal flow can help prevent localised flooding. Vegetation and branches can become dislodged during high flow events, They can then wash on to downstream structures causing blockages which increase the likelihood of flooding.

Ease of maintenance

Removing dense vegetation allows better access for maintenance activities. People and machinery can navigate to the assets more effectively. This makes it easier to inspect and report blockages and other defects.

Typical methods

We usually manage trees and vegetation by:

- mechanical or manual control
- chemical control

Mechanical or manual control is:

- physically pruning to remove dead and unwanted branches
- thinning by removing excess vegetation.
- Mowing or strimming overgrown vegetation

Chemical control chemicals to target excess vegetation. You can use species specific or less concentrated herbicides to avoid creating bare patches on embankments.

Applicable asset categories

You should carry out tree and vegetation management on the following asset categories:

- Amenities
- asset complex
- buildings and compounds
- channel
- defence
- drainage system
- instruments
- land
- structure

Good practice standards

- ✓ You should remove all arisings from the asset. On some suitable watercourses you can consider,
  - retaining trees and bushes for reuse in another location as woody debris
  - attaching them securely to a riverbed or bank to create habitat.
- ✓ On watercourses, you should only remove overhanging vegetation and branches up to the height of the bank.[1]
- ✓ You should normally carry out these activities once a year.

Environmental considerations

You should:

- ✓ carry out tree and bush work between September and mid- February, unless nesting birds are present.
- ✓ consider the environmental benefit of habitat piles or woody debris when you manage trees – but remember that these may need to be secured in place.
- ✓ consider the flood risk and whether any downstream structures could become blocked if these piles or debris move.

Burrowing animal control

It is essential you manage burrowing animals on flood risk assets to maintain the integrity and effectiveness of these critical structures. Doing so helps with:

- structural integrity
- risk reduction
- vegetation protection
- legal and environmental considerations

Your specific approach may vary based on local regulations and conditions. However, there are some general principles you should follow.

Structural integrity

Burrowing animals, such as rats, can undermine the structural integrity of flood defence assets. Their burrows:

- weaken embankments, walls, and other structures
- increase the risk of failure during floods

Regular burrowing animal control helps prevent damage caused by their activities. This makes sure flood defences remain robust and effective.

Risk reduction

Burrowing animals can create holes or tunnels in earth embankments. These can allow water to seep through which compromises the asset's ability to hold back floodwaters. Managing burrowing animal populations reduces the risk of breaches and subsequent flooding.

Vegetation protection

Some burrowing animals feed on vegetation. This can damage grass or shrubs on flood embankments if it is not stopped. Controlling burrowing animal supports vegetation growth, which in turn stabilises the soil and reduces the risk of erosion.

Legal and environmental considerations

Burrowing animal control is part of responsible asset management. You should consider the ecological impacts.

Typical methods

The most common methods of pest control include:

- chemical control and rodenticides
- physical control, including traps or barriers
- habitat modification, including devices that admit high frequency sound and vibrations to discourage burrowing animals

Applicable asset categories

You should carry out burrowing animal control on the following asset categories:

- asset complex
- buildings and compounds
- channel
- defence
- drainage system
- land

Good practice standards

You should:

- ✓ inspect regularly – this will help you identify signs of burrowing animal activity including burrows, nests, or other evidence.
- ✓ intervene early – addressing issues promptly prevents damage.
- ✓ use an integrated pest management (IPM) approach – this combines various strategies, including biological control, habitat modification, and chemical treatments to effectively manage burrowing animals while minimising the environmental impact.
- ✓ use barrier methods - install barriers, for example mesh screens or grates to prevent burrowing animals from accessing vulnerable areas of flood defence assets.
- ✓ monitoring - use monitoring tools, for example, motion-activated cameras to assess burrowing animal activity and adjust control measures accordingly.

Environmental considerations

You must:

- ✓ get advice from and consult with biodiversity experts.
- ✓ align with environmental regulations and consider the impact on non-target species.
- ✓ Get special licences if need – some species, including badgers water voles and beavers and their sets are protected.
- ✓ use humane methods of pest control wherever possible.

Silt and sediment management

It is important to manage silt and sediment so that you do not affect water flow and channel capacity.

Water flow and channel capacity

Accumulated silt and sediment can:

- reduce the flow capacity of watercourses
- restrict water flow under bridge structures

Channels that are shallower due to sediment buildup, cannot convey as much water during heavy rainfall or flood events. This can be an issue if the flow capacity of a watercourse has a direct impact on flood risk.

If you remove excess silt in these situations:

- the channel flow capacity is maintained
- water can flow freely preventing localised flooding

Remember that sediment removal is not applicable in all circumstances. It is often less effective than other forms of maintenance. You should assess each location to understand the:

- effectiveness
- sustainability
- environmental impact
- value for money

Typical methods

You can remove sediment in several ways. Two typical approaches are:

- mechanical dredging
- suction dredging

Mechanical dredging involves machinery, for example dredgers or excavators to physically scoop up sediment from water bodies. You can normally use this if there is good access and large-scale removal is required.

Suction dredging uses suction pumps to lift sediment from the bottom. It is suitable for both fine and coarse sediments. You normally use this if access is an issue or around a structure, such as a bridge.

Silt and sediment management (continued)

Applicable asset categories

You can carry out silt and sediment management on the following asset categories:

- asset complex
- channel
- drainage system
- land
- structure

Good practice standards

✓ Sediment control works best where the flow of water is slowed by using a barrier.

Examples include:

- coffer dam
- silt curtains
- flumes
- sedi-mats
- straw bales
- rock filter dams.

✓ You should slow water over a long length of channel to maximise the amount of settlement taking place. It is important to remove as much trapped sediment as possible to avoid releasing a plume when the barrier is removed.

Environmental Considerations

You should consider:

✓ sediment removal – this can harm fish and downstream spawning grounds, so consider using sediment barriers to mitigate impacts.

✓ silt in water – suspended silt lowers oxygen levels and may release harmful chemicals- test silt and sediment for contaminants.

✓ long-term management – look at upstream vegetation management and agricultural methods to reduce soil runoff.

✓ waste management – you may need a waste license or exemption before you carry out the activity.

Drainage maintenance

Maintaining drainage assets is crucial for reducing flood risk and minimising disruption from surface water flooding. It helps with:

- effective water management
- preventing blockages
- infrastructure resilience
- urban flooding mitigation

Effective water management

Properly maintained drains, culverts, and ditches efficiently channel rainwater away from urban areas and agricultural land. This prevents waterlogging and reduces the risk of flooding.

Preventing blockages

Regular maintenance ensures that drains remain clear of debris, leaves, and sediment. Blocked drains can lead to localised flooding during heavy rainfall.

Infrastructure resilience

Well-maintained drainage systems withstand extreme weather events, preventing damage to roads, buildings, and utilities. This resilience is essential for flood risk reduction.

Urban flooding mitigation

Urban areas with efficient drainage systems experience less surface water flooding. Properly functioning drains prevent water from pooling on streets and in basements.

Typical methods

You can normally maintain drainage using:

- CCTV drain surveys - to highlight any maintenance or repair issues
- drain rodding and jetting – this can remove blockages
- vacuum tankers or gulley suckers- to clear debris and prevent solidification in manholes and chambers

Drainage maintenance (continued)

Applicable asset categories

You should carry out drainage maintenance on the following asset categories:

- asset complex
- channel
- drainage system
- land
- structure

Good practice standards

Drainage maintenance schedules vary based on:

- location
- system type
- usage
- local priorities

However, you should follow these general guidelines:

✓ regular inspections – you should conduct visual inspections quarterly or semi-annually - look for signs of blockages, leaks, or deterioration

✓ clear debris – you should remove leaves, sediment, and debris from drains at least twice a year, both before and after the rainy season

✓ jetting and rodding – you should schedule professional jetting or rodding every 1 to 2 years to minimise blockages.

✓ CCTV Surveys – you should carry out detailed surveys using cameras every 3 to 5 years to assess the entire drainage network.

Environmental considerations

✓ material disposal – you must properly dispose of debris removed from drainage assets.

✓ surface water drains - debris and sediment from road runoff may contain hydrocarbons and chemicals affecting water quality.

✓ environmental awareness – you should consider the impact of washing pollutants into natural watercourses or groundwater abstraction zones when flushing or jetting drains.

Coastal maintenance

Coastal maintenance plays a crucial role in reducing flood and erosion risk. It helps with:

- protection and resilience
- limiting damage
- climate change adaptation

Protection and resilience

Coastal maintenance helps provide protection from flooding and erosion. It benefits:

- communities
- properties
- infrastructure

Well-maintained coastal defences act as barriers against rising sea levels and storm surges. Defences include:

- sea walls
- embankments
- natural features

Limiting damage

By preventing erosion and maintaining coastal structures, we limit damage to property and reduce business losses.

Climate change adaptation

Climate change is causing extreme weather events and rising temperatures. It highlights how important coastal resilience is. Maintaining our coastal assets properly aligns with national strategies to make our country more resilient to flooding and coastal change.

Coastal maintenance (continued)

Applicable asset categories

You should carry out coastal maintenance on the following asset categories:

- asset complex
- beach structure
- defence
- land
- structure

Good practice standards

Various structures are considered as or used as coastal protection structures, these include:

- groynes
- seawalls
- break waters
- dunes

They all require different forms of maintenance at different frequencies depending on the specific need of the location.

Typical activities could include:

- ✓ inspection, maintenance and repairs - this makes sure the coastal structures remain effective
- ✓ cliff stability surveys - these assessments evaluate the stability of coastal cliffs
- ✓ inspection of beach transition - this point of transition can suffer erosion and impact on overall flood protection
- ✓ beach profile or topographic surveys - these surveys measure beach elevation and shape
- ✓ beach recycling or reprofiling – these are soft engineering strategies that manage coastal erosion

Environmental considerations

When carrying out coastal flood and erosion work, it's crucial to consider environmental factors.

These include:

- preserving habitats
- managing sediment
- monitoring water quality

✓ You must also get any necessary permits, for example environmental permits and land drainage consent, so you are compliant with regulations.

Minor repair work

Minor repair work may be classed as reactive maintenance following a report of a defect. Defects may be identified by a visual inspection or a member of the public.

Minor repair work is important for:

- optimum performance
- cost efficiency

Optimum performance

Completing minor repairs of assets helps to extend their asset life. If you keep an asset in good condition, it can perform and operate as expected, and not deteriorate further.

Cost effective

Carrying out small scale repairs regularly on assets to avoid deterioration is more economical. It usually costs less than reconditioning or replacing an asset which has deteriorated and is in poor condition.

Typical methods

Minor repair work on assets can vary. Typical examples include:

- brickwork repair – including joint repairs or replacement of damaged bricks
- fixing small cracks or in-filling of voids – done on floodwalls or embankments using suitable materials
- installing or repairing erosion control measures – for example rock revetment
- painting and corrosion protection
- sealant replacement or repair – done to joints and seams
- seal replacement – done on control assets and flood gates
- replacing faulty flap valves
- replacing faulty components

Minor repair work (continued)

Applicable Asset Categories

You should carry out minor repair work on the following asset categories:

- aids to navigation
- asset complex
- beach structure
- buildings and compounds
- channel crossing
- defence
- drainage system
- instruments
- MEICA
- structure

Good practice standards

Minor repairs can vary based on:

- location
- asset type
- usage
- local priorities

Generally, you should:

- ✓ Carry out regular inspections - visual inspections, quarterly or semi-annually to help spot signs of damage, cracking, leaks, or deterioration
- ✓ Intervene early – carry out small repairs promptly usually avoids more extensive and costly repairs later.

Environmental considerations

When carrying out repairs to flood defences, you must manage environmental considerations.
You should:

- schedule repairs during non-breeding seasons
- protect existing habitats
- use wildlife-friendly barriers
- monitor wildlife activity

You must have the necessary consents when working on flood defences. If you're dealing with main rivers or sea defences in England, check if you need a permit or simply inform
the Environment Agency about your work.

If your work involves other watercourses, you will need to apply for ordinary watercourse consent. You can do this through the internal drainage board (IDB) or your lead local flood authority via your local council.

Environment Agency

Introduction to asset inspection

Regular inspections of flood risk assets are crucial for:

- safety
- risk mitigation
- legal compliance
- cost-effectiveness

If we assess the condition of flood defences and identify vulnerabilities early, we can reduce the risk of catastrophic failure during floods.

Complying with regulations makes sure responsible authorities protect communities and property. Proactive maintenance extends asset lifespan and prevents costly emergency repairs.

This guide outlines good inspection practices in England for flood risk asset management. It establishes a minimum standard and a common approach to condition grading assets.

This consistency will let us integrate data in the future and share it across RMAs. A shared understanding of asset condition will:

- enhance the holistic view of flood risk from all sources
- create opportunities for collaborative investment and stronger incident response plans

Environment Agency

Operational checks

Operational checks on flood risk assets are crucial for effective flood management for several reasons:

- asset functionality
- training and preparedness
- debris removal
- public safety

Asset functionality

Regular checks ensure that flood risk assets function properly. Assets include:

- raised defences
- debris screens
- flood gates
- culverts

Checks help prevent blockages and make sure assets remain able to manage flood risk. During an operational check, you may need to fully operate the asset, for example open and close a flood gate. This makes sure it will perform as expected during a flood event.

Training and preparedness

Operational checks also help prepare incident response teams for incidents. They:

- familiarise them with the assets
- rehearse the operation of the asset and any emergency systems and alarms

Debris removal

Assets like debris screens on culverts are designed to catch and enable efficient removal of debris from watercourses. Without checks, blockages could increase flooding or damage other infrastructure.

Public safety

Operational checks safeguard against failures that could endanger people or property during floods.

Operational checks (continued)

Applicable asset categories

You should carry out operational checks on the following asset categories:

- asset complex
- instruments
- defence
- MEICA
- drainage system
- structure

Typical frequency

The frequency of operational checks on flood risk assets can vary. There are some general guidelines you can follow:

Operational checks are conducted all year round on flood risk management assets. The frequency is determined by the flood or safety risk.

Typical frequencies are:

- high priority assets - every 6 to 12 months.
- medium priority assets - 12 to 24 months.
- low priority assets - greater than 24 months.

Normally before, during and after storm events we increase the frequency of checks.

This helps:

- make sure the assets are ready to operate
- check for any damage post the flooding incident.

Visual inspection

Visual Inspections on flood risk assets are important for several reasons:

- to check asset condition
- support early intervention
- allow a risk-based approach

Asset condition

A visual inspection will:

- help you assess an asset's condition
- provides a good indication of performance in a cost-effective way.
- help organisations understand and detect any changes in condition of the visible elements of an asset over time

Early intervention

Assessing the condition and performance of an asset regularly will help you intervene at an appropriate time.

Risk management

Improving organisational understanding of asset performance can support a risk-based approach to asset management and long-term investment planning.

Applicable asset categories

You should carry out visual inspections on the following asset categories:

- aids to navigation
- buildings and compounds
- channel crossing
- instruments
- structure
- amenities
- beach structure
- defence
- land
- asset complex
- channel
- drainage system
- MEICA

Visual inspection (continued)

Typical frequency

The frequency of visual inspections on flood risk assets can vary. They may be:

- scheduled
- part of a risk-based programme
- driven by local priorities
- carried out on an ad hoc basis following a flood incident
- carried out after remedial works have been completed

You should conduct visual inspections on flood risk management assets all year round. The frequency is driven by priority.

Typical frequencies are:

- high priority assets - every 6 to 12 months
- medium priority assets - 12 to 24 months
- low priority assets - greater than 24 months

Good practice - condition assessment

The Environment Agency's Flood Risk and Coastal Erosion Asset Inspection Accreditation scheme (or the T98 course) is seen as good practice across the industry.

Assets can be graded to understand their condition during a visual inspection. Table 4 gives an example of the grading definitions.

Grade	Description
1. Very good	Cosmetic defects that will have no effect on performance.
2. Good	Minor defects that will not reduce the overall performance of the asset.
3. Fair	Defects that could reduce performance of the asset.
4. Poor	Defects that have potential to deteriorate and significantly reduce performance of the asset. Further investigation required.
5. Very poor	Severe defects resulting in significant or complete performance failure.

Engineering inspection

Engineering inspections provide a more detailed assessment of an assets condition. They can be either intrusive or non-intrusive. They are usually triggered when:

- additional information is needed for an asset
- a visual inspection picks up an issue worthy of investigation

The inspection may provide further information to support decision making on resolving observed or perceived issues.

However, an engineering inspection can also highlight unseen or further issues that may not be obvious visually. An example could be the structural integrity of an asset. This is why engineering judgement is usually applied in detailing the inspection required. This is either done proactively as part of a regular inspection regime or process, or ad hoc, triggered by visual changes to the asset.

Typical frequency

The frequency of engineering inspections on flood risk assets can vary. They are typically carried out to assess the:

- consequences of further deterioration or failure
- structural integrity of foundations and structures, including walls.
- stability or leakage issues following a flood or storm event
- change in loading on an asset, such as removal of neighbouring structures or changes in the water table

The frequency of inspection may be affected by:

- local priorities
- the asset age
- how regularly the asset is used

If you think you need an engineering inspection following a visual inspection you should consider:

- the likely cost of any foreseeable repairs
- whether the cost of the inspection could be more than a minor repair to fix the observed issue

Examples of engineering inspection

Engineering inspections could include:

- ground Investigations – these confirm underlying ground conditions and help to inform stability and leakage issues relating to geotechnical factors
- structural testing including coring – these confirm construction materials, structural assessments and potential deterioration factors
- internal inspections using borescopes or endoscopy – these collect visual inspection information where normal access is not possible and helps assess the presence of voids and internal cracking
- Load testing – this helps to confirm the ability of a structure to withstand imposed loads

Engineering inspection (continued)

Applicable asset categories

You may need to carry out engineering inspections on the following asset categories:

- asset complex
- channel crossing
- beach structure
- defence
- channel
- drainage system
- land
- MEICA structure

Good practice standards

For ground inspections:

BS 5930:2015+A1:2020 code of practice for site investigations

Specialist inspection

A specialist inspection:

- is a more detailed investigations where specialist knowledge in a particular field is needed
- usually required specialist equipment
- generally involves intrusive techniques

These inspections are important to check:

- structural integrity
- long term performance

Structural integrity

You should check an assets structural component to make sure it is fit for purpose under normal operating conditions. This confirms it can still perform should conditions exceed the original design.

Long term performance

Structural deterioration will influence the performance of an asset over the long term. Deterioration can be due to:

- corrosion
- fatigue failures causing cracks
- defective materials

Typical frequency

The frequency of specialist inspections on flood risk assets can vary. They are usually triggered when additional information is needed for an asset following an engineering or visual inspection.

Applicable asset categories

You may need to carry out specialist inspections on the following asset categories.

- asset complex
- defence
- channel
- drainage system
- channel crossing
- instruments
- land
- MEICA
- Structure

Specialist inspection (continued)

Examples of specialist inspections

Specialist inspections include:

- bridge inspections – these involve assessing the condition, safety, and integrity of bridges and are crucial for maintaining infrastructure quality
- confined space inspections – these involve assessing environments not designed for continuous occupancy, for example tanks, chambers, tunnels and culverts
- diving inspections – these are conducted underwater by professional divers and are used to check structural integrity below the water line, for example on bridges and dams
- asbestos inspections – these examine buildings for asbestos-containing materials (ACMs)

Good practice standards

You should follow these standards for specialist inspections:

- Confined Space Regulations 1997
- The Diving at Work Regulations 1997
- Control of Asbestos Regulations 2012
- CS450 Inspection of highway structures

Statutory inspection

Statutory inspections are required by law and must be complied with. They are an essential part of ensuring the safety of the asset to operate. They must be completed by a competent person. Statutory inspections include:

- reservoir inspections
- plant and machinery inspections

The main regulations you need to follow are:

- Provision and Use of Work Equipment Regulations 1998 (PUWER): Ensuring work equipment can be operated, adjusted and maintained safely.
- Lifting Equipment Regulations 1998 (LOLER): Assessing equipment used for lifting is fit for purpose and appropriate for the task.
- Pressure Systems Safety Regulations 2000: Assessing pressure vessels, boilers, and pipelines to prevent leaks and failures.
- Reservoirs Act 1975:Legal framework for ensuring reservoir safety

Applicable asset categories

You may need to carry out statutory inspections in the following asset categories.

- aids to navigation
- asset complex
- buildings and compounds
- defence
- drainage system
- MEICA
- structure

Typical frequency

The frequency of statutory inspections on flood risk assets can vary. You should determine it based on risk assessments and by considering manufacturers recommendations.

Work equipment which is exposed to environmental conditions that may cause deterioration should be inspected at suitable intervals. You should also inspect it after exceptional circumstances which may jeopardise the safety of the asset.

You need to carry out inspections throughout the lifetime of the equipment. This will confirm equipment, and accessories remain safe to use and allow you to detect and remedy deterioration in good time.

Statutory inspection (continued)

You should carry out inspections:

- before use for the first time
- after assembly and before use at each location
- regularly, while in service
- following exceptional circumstances

You should conduct through examinations according to the following schedule, unless there is an 'examination scheme' specifying other intervals.

- 6 months - for lifting equipment and any associated accessories used to lift people
- 6 months - for all lifting accessories
- 12 months - for all other lifting equipment

It is good practice to complete Electrical Installation Condition Reports every 3 to 5 years. These demonstrate maintenance regimes for assets under the PUWER regulations.

Good practice standards

You should follow electrical inspection and testing through Electrical Installation Condition Reports to make sure the safety and reliability of electrical systems in infrastructure assets.

Safety inspection

You should carry out safety inspections to identify any defects that could be hazardous or cause injury. This makes sure the public and operators are safe.

It is important these inspections are carried out by trained and competent officers. They will be able to:

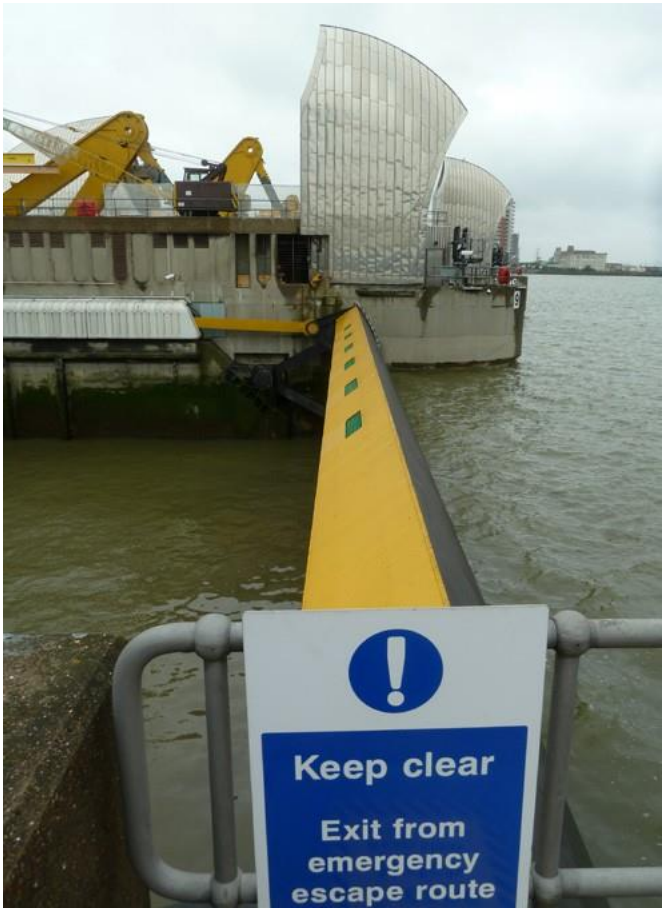
- identify potential issues
- provide technical advice
- carry out remedial actions

Asset owners are required by law to ensure the public are not harmed by their assets. There are many forms of legislation and regulations you must follow if you are responsible for flood and coastal assets. Doing so shows that you have discharged your duties by law.

Applicable Asset Categories

You may need to carry out safety inspections in the following asset categories.

- amenities
- asset complex
- beach structure
- channel
- defence
- drainage system
- land
- MEICA
- structure



Typical Frequency

The frequency of safety inspections on flood risk assets varies depending on the:

- asset type
- location of the asset
- risk

You should plan a programme of inspections in advance.

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Safety inspection (continued)

Examples of safety hazards

Table 5 shows some of the potential hazards you may need to consider during a safety inspection.

Category	Hazards	Examples
Mechanical	Slippery or uneven surfaces	Leading to falls on a level
Mechanical	Persons falling from height	Distances of the fall from ditches, stairs, ladders, parapets, etc
Mechanical	Objects falling from height	Tools, materials, stored objects impacting the public
Mechanical	Moving objects	Gates, barriers, machinery, unstable/wobbly pontoons
Mechanical	Moving water	Waves, rivers, excessive rainfall
Mechanical	Moving air	Wind and its action, doors banging, overturning, trees, slender walls /columns, narrow walkways
Mechanical	Machinery movement	Automated movement, rotating shafts, reciprocating pushrods, escalators, conveyors and guillotine actions
Mechanical	Manual lifting	Heavy units, awkward shapes, awkward gates
Mechanical	Poor ergonomics	Work space, passing points, narrow spaces, shortcuts
Mechanical	Entrapment	Poor access or egress, incoming tides, rip tides, sandbanks
Mechanical	Transportation	Vehicle movements, parking arrangements, lines of sight, footways entering blind spots
Mechanical	Stored energy	Coiled springs, closers, counterbalances
Chemical	Lack of oxygen	Confined spaces
Chemical	Gas enriched areas	Poor ventilation, carbon dioxide, carbon monoxide, battery charging
Chemical	Contact with hazardous substances	Touching, working with absorption of chemicals
Chemical	Ingestion	Entry via mouth, e.g. paint thinners, wood preservative, anticlimb paint
Chemical	Degradation of stored materials	Oxidation of materials, fumes, acids, spontaneous combustion
Biological and Psychological	Inhalation	Odours, fumes, dust
Biological and Psychological	Transmitted by personal contact	Needles/fluids
Biological and Psychological	Ingestion	Contaminated food, personal hygiene
Biological and Psychological	Excessive workload	Repetitive maintenance, too onerous
Biological and Psychological	Lack of communication or control	Uninformed repetition of mistakes
Biological and Psychological	Physical violence, bullying, intimidation	By the public and in the workplace
Biological and Psychological	Unfamiliarity	Uncertainty of access, egress and how things operate

Safety inspection (continued)

Good practice standards

You should follow:

- Health and Safety at Work Act (1974)
- Management of Health and Safety at Work Regulations (1999)
- Construction (Design and Management) Regulations 2015 (CDM)

It is good practice to have safe systems of work. These reduce the risk of harm and protect employees from unnecessary risks to their health.

Summary of Recommended Asset Maintenance and Inspections by category

Table 6 shows the recommended maintenance and inspection activities RMAs need to consider as asset owners.

Asset Category	Types of Maintenance									Types of Inspection					
	Debris Removal	Grass Cutting	Weed and Invasive Plant Control	Tree and Vegetation Management	Burrowing Animal Control	Silt and Sediment Management	Drainage Maintenance	Coastal Maintenance	Minor Repair Work	Operational Checks	Visual Inspections	Engineering Inspection	Specialist Inspection	Statutory Inspection	Safety Inspection
Aids to Navigation									✓		✓			✓	
Amenities		✓		✓							✓				✓
Asset Complex	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Beach Structure								✓	✓		✓	✓			✓
Building and Compounds		✓	✓	✓	✓				✓		✓			✓	
Channel	✓	✓	✓	✓	✓	✓	✓		✓		✓	✓	✓		✓
Channel Crossing									✓		✓	✓	✓		
Defence		✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓
Drainage System	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓
Instruments		✓	✓	✓					✓	✓	✓		✓		
Land	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓		✓
MEICA									✓	✓	✓	✓	✓	✓	✓
Structure	✓		✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

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The future of asset inspection and Maintenance

Flood risk asset maintenance and inspection: good practice guide

The rapid advancement of digital tools and techniques will transform how and when inspections and maintenance are carried out. Integrating these technologies will make asset management:

- more efficient
- safer
- cost-effective

You can use these innovations to move from reactive to predictive maintenance, which will enhance asset reliability and performance.

Drones

Drones can:

- access hard-to-reach areas
- capture the high-resolution images and videos needed for detailed inspections
- reduce the need for manual inspections
- enhance safety and efficiency
-

For example, drones could:

- inspect bridges without requiring workers to climb or use scaffolding
- work in confined spaces

Satellite Imagery

Satellite imagery provides a broad view of large assets, such as watercourses and embankments. It has been expensive in the past, but the cost has reduced as more satellites have been put into orbit. This has also increased the frequency of data.

Satellite imagery can help:

- monitor environmental changes
- detect potential hazards
- and plan maintenance activities
-

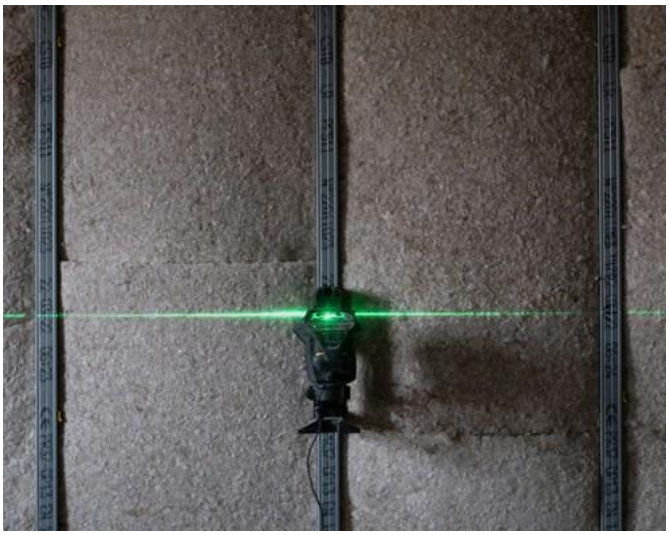
It is especially helpful for assets spread over vast geographical areas.

LiDAR (light detection and ranging)

LiDAR technology uses laser to create a detailed survey of assets. It is highly effective for inspecting infrastructure like bridges and embankments.
LiDAR can:

- detect structural issues
- and measure deformations with high precision

This support preventive maintenance. The Environment Agency has successfully used LiDAR to identify potential features that could cause weaknesses in embankments. We have then targeted more frequent inspections at those locations.



Sensors and IoT (internet of things)

Sensors embedded in equipment can continuously monitor parameters like:

- temperature
- vibration
- pressure

IoT platforms collect and analyse this data in real-time, providing insights into the health of assets. This continuous monitoring enables timely interventions and reduces the risk of unexpected failures.

Reliability-centered maintenance (RCM)

RCM is a systematic approach to maintenance that focuses on ensuring assets continue to perform their required functions. It integrates digital tools like:

- artificial intelligence
- sensors
- predictive analytics

These allow RCM to:

- optimise maintenance schedules
- prioritise critical tasks
- extend the lifespan of assets

Artificial intelligence (AI)

AI algorithms analyse data from various sources. They can predict equipment failures before they occur.

Machine learning models can identify patterns and anomalies in data, enabling predictive maintenance. This reduces downtime and maintenance costs by addressing issues proactively.

Digital twin

Digital twins integrate data to create real-time, virtual representations of physical environmental assets and systems, such as flood defences and infrastructure.

They integrate data from:

- sensors
- IoT devices
- other sources

This allows continuous monitoring and simulation of these assets throughout their lifecycle. This technology:

- facilitates predictive maintenance
- allows issues to be identified and addressed before they become critical
- enhances efficiency by reducing the need for physical inspections- because digital twins can analyse large volumes of data to support simulations, scenario planning, and predict outcomes.

There are demonstrable digital twins in the UK water industry. These:

- optimise asset operations, factoring in changing demands and weather patterns
- can help plan and rehearse maintenance activities, reducing abortive works and improving onsite health and safety

The UK's National Digital Twin Programme (NDTP)

GOV.UK (www.gov.uk) is working to develop a connected ecosystem of digital twins to enhance the management and optimisation of national infrastructure. This future connected system of digital twins will:

- enhance decision-making
- drive efficiency and sustainability
- encourage transparency across the UK's infrastructure

Environment Agency

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