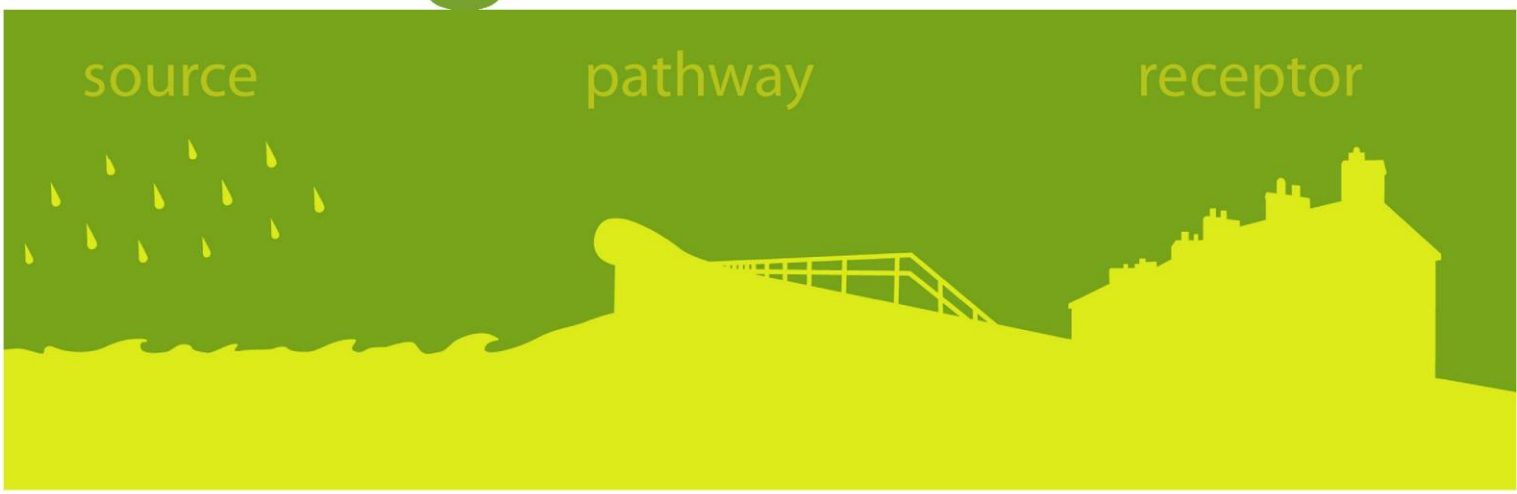
defra
Department for Environment Food and Rural Affairs

Environment Agency

delivering benefits through evidence



Technical Report – FCRM Assets: Deterioration Modelling and WLC Analysis

Appendix B: Maintenance Standards

Report – SC060078

Flood and Coastal Erosion Risk Management Research and Development Programme

Appendix B – Maintenance Standards

The list of assets covered by Environment Agency Report: Delivering consistent standards for sustainable asset management, FCRM Asset Management Maintenance Standards, Version 2010 (March) are:

- Vertical Concrete Walls
- Vertical Brick Walls
- Sheet piled structures
- Embankments
- Culverts
- Open Channels (Simple Channels)
- Open Channels (Engineered Channels)
- Outfalls
- Debris Screens

Maintenance Standards developed as part of this project are:

- Vertical Timber Walls
- Vertical Gabion Walls
- Sloping Walls (with flexible/rigid or impermeable/permeable protection)
- Demountable Defences – metal
- Demountable Defences - wood
- Beaches
- Rock Groynes
- Timber Groynes
- Offshore Breakwaters
- Dunes
- Salt marshes
- Weirs
- Flap valves
- Moveable Gates (Penstocks and Sluice Gates) – Manually operated
- Moveable Gates (Penstocks and Sluice Gates) – Electrically operated
- Flood Gates and Barriers

The maintenance standards developed as part of this project are presented below.

Asset: Vertical Timber Wall

Description of asset

Timber walls of different heights and located in different types of environment are covered. Works conducted will generally be as a result of asset inspection

AIMS asset classification: Defence// wall

Possible maintenance activities

Maintenance activity	Description
Vegetation clearance	Removal of young trees, shrubs and grass that may affect the structural stability/integrity of the wall Environmental management (off-site disposal of cleared vegetation)
Minor timber repair	Timber plank replacement Timber treatments
Wall repair / maintenance works	Minor repair works to keep the wall in the required condition Backfill replacement Scour protection Replacement of fixings Vermin control Replacing signs Repair fencing Graffiti Removal

Factors influencing maintenance unit cost rate

Factors influencing maintenance costs	Weighting factor	Score	Weighted score
Difficult access (e.g. energetic fluvial environment / marine plant required / macrotidal/divers needed, etc)	2		0
Wall prone to vandalism	2		0
Exposed environment => greater downtime	1		0
Wall > 1m high	1		0

Maintenance standard and maintenance unit cost range

Assumptions: Costs have been built up from consideration of activities and frequencies, informed by standards for vertical walls from EA FCRM Asset Management Maintenance Standards, Version 2010 (March)

Maintenance Standard - Maintain to target condition 2

Description of maintenance standard	
Maintenance activity	Frequency (times/year)
Vegetation clearance	0.3 - 0.5
Minor timber repair	0.1 - 0.5
Wall repair / maintenance works	1

Maintenance unit cost range (all activities as listed above) £/km/year			
Incl Manual clearance		Incl Mechanical clearance	
Low	High	Low	High
355	1,020	300	875

Maintenance Standard - Maintain to target condition 3

Description of maintenance standard	
Maintenance activity	Frequency (times/year)
Vegetation clearance	0.2 - 0.5
Minor timber repair	0.066 – 0.2
Wall repair / maintenance works	0.5 - 1

Maintenance unit cost range (all activities as listed above) £/km/year			
incl Manual clearance		incl Mechanical clearance	
Low	High	Low	High
135	695	100	550

Maintenance Standard - Maintain to target condition 4

Description of maintenance standard	
Maintenance activity	Frequency (times/year)
Vegetation clearance	0 - 0.2
Minor timber repair	0 – 0.05
Wall repair / maintenance works	0 - 0.3

Maintenance unit cost range (all activities as listed above) £/km/year			
incl Manual clearance		incl Mechanical clearance	
Low	High	Low	High
0	215	0	155

Confidence Score:* 4
** scale 1 low to 5 high, based on consideration of perceived confidence in source data, range of maintenance activities and potential impact of activity on condition*

Asset: Vertical Gabion Wall

Description of asset

Gabions walls of differing heights in both coastal and fluvial environments are considered here. Works conducted will generally be as a result of asset inspection

AIMS asset classification: Defence// wall// gabions

Possible maintenance activities

Maintenance activity	Description
Vegetation clearance	Removal of young trees, shrubs and grass that may affect the structural stability/integrity of the wall Environmental management (off-site disposal of cleared vegetation)
Wall repair / maintenance works	Minor repair works to keep the wall in the required condition Vermin control Replace signs Repair fencing

Factors influencing maintenance unit cost rate

Factors influencing maintenance costs	Weighting factor	Score	Weighted score
Difficult access (e.g. energetic fluvial environment / marine plant required / macrotidal/divers needed, etc)	2		0
Wall prone to vandalism	2		0
Exposed environment => greater downtime	1		0
Wall > 1m high	1		0

Maintenance standard and maintenance unit cost range

Assumptions: Using brick walls costs (from EA FCRM Asset Management Maintenance Standards, Version 2010 (March)) + 50% , due to ease of damage
Only one maintenance regime possible for gabion walls – Basic (i.e. target Grade 4)

Maintenance Standard - Maintain to target condition 2 (Not used)

Maintenance Standard - Maintain to target condition 3 (Not used)

Maintenance Standard - Maintain to target condition 4

Description of maintenance standard	
Maintenance activity	Frequency (times/year)
Vegetation clearance	1
Wall repair / maintenance works	0.2 – 0.5

Maintenance unit cost range (all activities as listed above) £/km/year			
incl Manual clearance		incl Mechanical clearance	
Low	High	Low	High
100	323	80	233

Confidence Score:* 3
**scale 1 low to 5 high, based on consideration of perceived confidence in source data, range of maintenance activities and potential impact of activity on condition*

Asset: Sloping Wall (with Turf protection)

Description of asset

Sloping walls are structures built on the face of the bank/shore that they protect. They may be constructed of masonry, rock, brick or concrete, and often have toe protection features. This standard covers sloping walls with turf protection. Other types are covered by: Sloping walls with slope protection or revetments.
Maintenance works will generally be a result of inspections

AIMS asset classification: Defence// embankment

Possible maintenance activities

Maintenance activity	Description
Vegetation clearance	Grass cut, invasive weed control and tree work Removal of young trees, shrubs and grass that may affect the structural stability/integrity of the wall Environmental management (disposal of cleared vegetation)
Wall repair / maintenance works	Minor repair works to keep the wall in the required condition Backfill replacement Scour protection Vermin control Replacing signs Repair of fencing

Factors influencing maintenance unit cost rate

Factors influencing maintenance costs	Weighting factor	Score	Weighted score
Difficult access (e.g. energetic fluvial environment / marine plant required / macrotidal, site located far from a road, overhead power cables, protected species, etc.)	2		0
Exposed environment => rapid degradation and greater downtime during maintenance	2		0
Wall > 1 m high	1		0

Maintenance standard and maintenance unit cost range

Assumptions Based upon Embankments (from EA FCRM Asset Management Maintenance Standards, Version 2010 (March))

Maintenance Standard - Maintain to target condition 2

Description of maintenance standard	
Maintenance activity	Frequency (times/year)
Vegetation clearance	2 - 3
Wall repair / maintenance works	0.5 - 1

Maintenance unit cost range (all activities as listed above) £/km/year			
incl Manual clearance		incl Mechanical clearance	
Low	High	Low	High
2,770	17,225	80	5,430

Maintenance Standard - Maintain to target condition 3

Description of maintenance standard	
Maintenance activity	Frequency (times/year)
Vegetation clearance	2 – 3
Wall repair / maintenance works	0.1 - 0.5

Maintenance unit cost range (all activities as listed above) £/km/year			
incl Manual clearance		incl Mechanical clearance	
Low	High	Low	High
1,385	17,225	20	5,430

Maintenance Standard - Maintain to target condition 4

Description of maintenance standard	
Maintenance activity	Frequency (times/year)
Vegetation clearance	1 - 2
Wall repair / maintenance works	0 - 0.1

Maintenance unit cost range (all activities as listed above) £/km/year			
incl Manual clearance		incl Mechanical clearance	
Low	High	Low	High
250	2,615	10	725

Confidence Score:* 4
** scale 1 low to 5 high, based on consideration of perceived confidence in source data, range of maintenance activities and potential impact of activity on condition*

Asset: Sloping Wall with Slope Protection or Revetment (all Permeable and impermeable sloping walls)

Description of asset

Sloping walls are structures built on the face of the bank/shore that they protect. They may be constructed of masonry, rock, brick or concrete, and often have toe protection features. Maintenance works will generally be a result of inspections

AIMS asset classification: Defence// embankment

Possible maintenance activities

Maintenance activity	Description
Vegetation clearance	Removal of young trees, shrubs and grass that may affect the structural stability/integrity of the wall Environmental management (disposal of cleared vegetation)
Wall repair / maintenance works	Minor repair works to keep the wall in the required condition Backfill replacement Replacement of missing / damaged components Sealant replacement Joint repair Scour protection Vermin control Replacing signs Repair of fencing Graffiti removal

Factors influencing maintenance unit cost rate

Factors influencing maintenance costs	Weighting factor	Score	Weighted score
Difficult access (e.g. energetic fluvial environment / marine plant required / macrotidal, site located far from a road, overhead power cables, protected species, etc.)	2		0
Exposed environment => rapid degradation and greater downtime during maintenance	2		0
Wall > 1 m high	1		0

Maintenance standard and maintenance unit cost range

Assumptions Using concrete walls costs (from EA FCRM Asset Management Maintenance Standards, Version 2010 (March)) for impermeable and permeable sloping walls

Maintenance Standard - Maintain to target condition 2

Description of maintenance standard	
Maintenance activity	Frequency (times/year)
Vegetation clearance	0.3 - 0.5
Wall repair / maintenance works	0.5 - 1

Maintenance unit cost range (all activities as listed above) £/km/year			
incl Manual clearance		incl Mechanical clearance	
Low	High	Low	High
270	855	210	710

Maintenance Standard - Maintain to target condition 3

Description of maintenance standard	
Maintenance activity	Frequency (times/year)
Vegetation clearance	0.2 - 0.5
Wall repair / maintenance works	0.1 - 0.5

Maintenance unit cost range (all activities as listed above) £/km/year			
incl Manual clearance		incl Mechanical clearance	
Low	High	Low	High
125	565	85	420

Maintenance Standard - Maintain to target condition 4

Description of maintenance standard	
Maintenance activity	Frequency (times/year)
Vegetation clearance	0 - 0.2
Wall repair / maintenance works	0 - 0.1

Maintenance unit cost range (all activities as listed above) £/km/year			
incl Manual clearance		incl Mechanical clearance	
Low	High	Low	High
0	200	0	140

*Confidence Score** 4
** scale 1 low to 5 high, based on consideration of perceived confidence in source data, range of maintenance activities and potential impact of activity on condition*

Asset: Demountable (Metal / Wooden) Defence

Description of asset

Demountable defences are temporary defences erected during periods of high water to protect areas at risk of flooding. They may be stand-alone or may require mounting brackets to be fixed in place in advance. Maintenance activities will generally be as a result of inspection

AIMS asset classification: Defence// demountable

Possible maintenance activities

Maintenance activity	Description
Vegetation clearance	Removal of young trees, shrubs and grass that may affect the erection of defences and/or the structural stability/integrity of the wall
	Environmental management (disposal of cleared vegetation)
Asset repair / maintenance works	Minor repair works to keep the asset in the required condition Treatment of timber Replacement of components, e.g., mounts Sealant replacement Corrosion removal / protection Repair of fencing Replacing signs Graffiti removal
Reactive obstruction removal	Remove any obstructions to erection of defences Environmental management (off-site disposal of removed debris)
Operative Training	Training of deployment staff

Factors influencing maintenance unit cost rate

Factors influencing maintenance costs	Weighting factor	Score	Weighted score
Height of defence	1		0
Storage costs for defences	2		0
Difficult access (e.g. site located far from a road, overhead power cables, protected sites, protected species etc.)	2		0
Prone to vandalism (e.g. fly tipping, graffiti)	1		0

Maintenance standard and maintenance unit cost range

Assumptions

Used 1.4 ratio manual:mechanical, based on vertical walls (mid-range value) (from EA FCRM Asset Management Maintenance Standards, Version 2010 (March))

Maintenance cost includes deployment of defences
Assumed maintenance costs for metal and wood are the same
Assumptions based on expert judgement

Maintenance Standard - Maintain to target condition 2

Description of maintenance standard	
Maintenance activity	Frequency (times/year)
Vegetation Clearance	1
Asset repair / Maintenance Works	0.5 - 1.0
Reactive Obstruction Removal	1 - 2
Operative Training	0.3 - 0.5

Maintenance unit cost range (all activities as listed above) £/km/year			
incl Manual clearance		incl Mechanical clearance	
Low	High	Low	High
1,525	4,500	1,089	3,214

Maintenance Standard - Maintain to target condition 3

Description of maintenance standard	
Maintenance activity	Frequency (times/year)
Vegetation Clearance	0.5 -1
Asset repair / Maintenance Works	0.3 - 0.5
Reactive Obstruction Removal	0.5 -1.0
Operative Training	0.3 - 0.5

Maintenance unit cost range (all activities as listed above) £/km/year			
incl Manual clearance		incl Mechanical clearance	
Low	High	Low	High
775	2,600	554	1,857

Maintenance Standard - Maintain to target condition 4

Description of maintenance standard	
Maintenance activity	Frequency (times/year)
Vegetation Clearance	0.3 - 0.5
Asset repair / Maintenance Works	0.2 - 0.3
Reactive Obstruction Removal	0.3 - 0.5
Operative Training	0.3 - 0.5

Maintenance unit cost range (all activities as listed above) £/km/year			
incl Manual clearance		incl Mechanical clearance	
Low	High	Low	High
475	1,800	339	1,286

*Confidence Score** 3
**scale 1 low to 5 high, based on consideration of perceived confidence in source data, range of maintenance activities and potential impact of activity on condition*

Asset: Beaches

Description of asset

Natural or man made beaches with no defences. Maintenance activities will generally be the result of an inspection

AIMS asset classification: Defence// beach

Possible maintenance activities

Maintenance activity	Description
Vegetation clearance	Removal of young trees, shrubs and grass that may affect the structural stability/integrity of the asset Environmental management (disposal of cleared vegetation)
Asset repair/ maintenance works	Beach recycling Beach renourishment Removal of debris Scour protection Replacing signs Repair of fencing
Inspections/monitoring	Visual inspection Topographic surveys Assessment of accretion/erosion trends

Factors influencing maintenance unit cost rate

Factors influencing maintenance costs	Weighting factor	Score	Weighted score
Nourishment/recycling required	2		0
Source of renourishment material	2		0
Area known to be prone to debris	1		0
Exposed Environment	1		0

Maintenance standard and maintenance unit cost range

Assumptions Based on variety of regional schemes recycling and renourishment programmes

Maintenance Standard - Maintain to target condition 2

Description of maintenance standard	
Maintenance activity	Frequency (times/year)
Vegetation clearance	1 – 0.5
Asset repair/ maintenance works	1 – 0.2
Inspections/monitoring	3

Maintenance unit cost range	
£/km/year	
Low	High
1,000	150,000

Maintenance Standard - Maintain to target condition 3

Description of maintenance standard	
Maintenance activity	Frequency (times/year)
Vegetation clearance	1 – 0.5
Asset repair/ maintenance works	0.5 – 0.1
Inspections/monitoring	2

Maintenance unit cost range	
£/km/year	
Low	High
800	50,000

Maintenance Standard - Maintain to target condition 4

Description of maintenance standard	
Maintenance activity	Frequency (times/year)
Vegetation clearance	0.5 – 0.2
Asset repair/ maintenance works	0.2 - 0.1
Inspections/monitoring	1

Maintenance unit cost range	
£/km/year	
Low	High
600	10,000

*Confidence Score** 1
**scale 1 low to 5 high, based on consideration of perceived confidence in source data, range of maintenance activities and potential impact of activity on condition*

Asset: Rock Groyne

Description of asset

Cross-shore structures designed to reduce longshore transport on open beaches or to deflect nearshore currents within an estuary. Rock groynes may be constructed from local rock or from rock shipped in from further afield. Maintenance to groynes occurs when identified during an asset inspection.

AIMS asset classification: Beach structure// groyne

Possible maintenance activities

Maintenance activity	Description
Asset repair / maintenance work	Minor repair works to keep the asset in the required condition Addition / replacement of rocks Repacking of rocks Fill replacement Scour prevention Replace signage Graffiti removal

Factors influencing maintenance unit cost rate

Factors influencing maintenance costs	Weighting factor	Score	Weighted score
Difficult access (e.g. energetic environment, far from road, marine plant required protected species, dive inspection required, etc.)	2		0
Exposed environment => rapid degradation and greater downtime during maintenance	2		0
Source of rock	1		0
The maintenance of each groyne may be undertaken as a stand alone maintenance activity	1		0

Maintenance standard and maintenance unit cost range

Assumptions:

Assuming only one type of vegetation clearance (manual)
High cost ranges adjusted for diver access
Unit of costs are per groyne (with an assumed length of 100m)
Standard built up from bottom-up consideration of activities, costs and frequencies

Maintenance Standard - Maintain to target condition 2

Description of maintenance standard	
Maintenance activity	Frequency (times/year)
Asset repair / maintenance work	1
Vegetation clearance	1
Dive inspection	0.2

Maintenance unit cost range
£/(100m groyne)/year

Low	High
153	495

Maintenance Standard - Maintain to target condition 3

Description of maintenance standard	
Maintenance activity	Frequency (times/year)
Asset repair / maintenance work	0.5 - 1
Vegetation clearance	0.5 - 1
Dive inspection	0.1

Maintenance unit cost range	
£/(100m groyne)/year	
Low	High
78	286

Maintenance Standard - Maintain to target condition 4

Description of maintenance standard	
Maintenance activity	Frequency (times/year)
Asset repair / maintenance work	0.3 – 0.5
Vegetation clearance	0.3 – 0.5
Dive inspection	0.05

Maintenance unit cost range	
£/(100m groyne)/year	
Low	High
48	198

*Confidence Score** 2
**scale 1 low to 5 high, based on consideration of perceived confidence in source data, range of maintenance activities and potential impact of activity on condition*

Asset: Timber Groyne

Description of asset

Cross-shore structures designed to reduce longshore transport on open beaches or to deflect nearshore currents within an estuary. Timber groynes are constructed from hardwoods to prolong asset life. Maintenance to groynes occurs when identified during an asset inspection.

AIMS asset classification: Beach structure// groyne

Possible maintenance activities

Maintenance activity	Description
Asset repair / maintenance work	Minor repair works to keep the asset in the required condition
	Timber plank replacement Timber treatments Replacement of fixings Adjust level of planking Recycling of built-up material to upstream site Replace signage

Factors influencing maintenance unit cost rate

Factors influencing maintenance costs	Weighting factor	Score	Weighted score
Aggressive environment	2		0
Source of timber	1		0
The maintenance of each groyne may be undertaken as a stand alone maintenance activity	1		0
Difficult access (e.g. energetic environment, far from road, marine plant required protected species, dive inspection required, etc.)	2		0

Maintenance standard and maintenance unit cost range

Assumptions:

Use same costs as timber walls, for manual clearance (adjusted for unit length of 100m), with high range cost adjusted to include diver access

No mechanical clearance

Unit of costs are per groyne (with an assumed length of 100m)

Nominal cost given for low in target condition 4

Maintenance Standard - Maintain to target condition 2

Description of maintenance standard	
Maintenance activity	Frequency (times/year)
Asset repair / maintenance work	1
Dive inspection	0.2

Maintenance unit cost range	
£/(100m groyne)/year	
Low	High

36	112

Maintenance Standard - Maintain to target condition 3

Description of maintenance standard	
Maintenance activity	Frequency (times/year)
Asset repair / maintenance work	0.5 - 1
Dive inspection	0.1

Maintenance unit cost range	
£/(100m groyne)/year	
Low	High
14	77

Maintenance Standard - Maintain to target condition 4

Description of maintenance standard	
Maintenance activity	Frequency (times/year)
Asset repair / maintenance work	0.1 - 0.3
Dive inspection	0.05

Maintenance unit cost range	
£/(100m groyne)/year	
Low	High
5	24

*Confidence Score** 3
**scale 1 low to 5 high, based on consideration of perceived confidence in source data, range of maintenance activities and potential impact of activity on condition*

Asset: Offshore Breakwater (Rock)

Description of asset
Along-shore structures designed to reduce wave energy impacting on the shoreline. Offshore breakwaters may be constructed from local rock or from rock shipped in from further afield. Maintenance to breakwaters occurs when identified during an asset inspection.

AIMS asset classification: Beach structure// breakwaters

Possible maintenance activities

Maintenance activity	Description
Asset repair / maintenance work	Minor repair works to keep the asset in the required condition Addition / replacement of rocks Repacking of rocks Fill replacement Scour prevention Replace signage Graffiti removal

Factors influencing maintenance unit cost rate

Factors influencing maintenance costs	Weighting factor	Score	Weighted score
Exposed environment => rapid degradation and greater downtime during maintenance	2		0
Source of rock	1		0
The maintenance of each breakwater may be undertaken as a stand alone maintenance activity	1		0
Dive inspection required	2		0

Maintenance standard and maintenance unit cost range

Assumptions: Unit of costs are per breakwater (with an assumed length of 100m)
Cost based on rock groynes, adjusted for more frequent repair

Maintenance Standard - Maintain to target condition 2

Description of maintenance standard	
Maintenance activity	Frequency (times/year)
Asset repair / maintenance work	1
Dive inspection	0.2

Maintenance unit cost range	
£/(100m breakwater)/year	
Low	High
153	495

Maintenance Standard - Maintain to target condition 3

Description of maintenance standard	
Maintenance activity	Frequency (times/year)
Asset repair / maintenance work	0.5 - 1
Dive inspection	0.1

Maintenance unit cost range	
£/(100m breakwater)/year	
Low	High
78	286

Maintenance Standard - Maintain to target condition 4

Description of maintenance standard	
Maintenance activity	Frequency (times/year)
Asset repair / maintenance work	0.3 - 0.5
Dive inspection	0.05

Maintenance unit cost range	
£/(100m breakwater)/year	
Low	High
48	198

*Confidence Score** 2
**scale 1 low to 5 high, based on consideration of perceived confidence in source data, range of maintenance activities and potential impact of activity on condition*

Asset: Dunes

Description of asset

Sand dunes are used in coastal areas to prevent flooding. To reduce the amount of sand being blown by the wind, the sand must be stabilised

AIMS asset classification: Defence// dunes

Possible maintenance activities

Maintenance activity	Description
Vegetation clearance	Removal of young trees, shrubs and grass that may affect the structural integrity of the dune Environmental management (disposal of cleared vegetation)
Asset repair/ maintenance works	Installation of control structures, e.g. wind traps and sand fences Replanting Dune reprofiling Vermin control Scour protection Replacing signs Repair of fencing
Inspections/monitoring	Visual inspection Habitat surveys Assessment of accretion/erosion trends

Factors influencing maintenance unit cost rate

Factors influencing maintenance costs	Weighting factor	Score	Weighted score
Replanting/reprofiling required	2		
Area known to be prone to debris and public access	1		
Exposed Environment	1		

Assumptions: Standard built up from bottom-up consideration of activities, costs and frequencies

Maintenance standard and maintenance unit cost range

Maintenance Standard - Maintain to target condition 2

Description of maintenance standard	
Maintenance activity	Frequency (times/year)
Vegetation clearance	1 – 0.5
Asset repair/ maintenance works	1 – 0.2
Inspections/monitoring	2

Maintenance unit cost range	
£/km/year	
Low	High
1,000	60,000

Maintenance Standard - Maintain to target condition 3

Description of maintenance standard	
Maintenance activity	Frequency (times/year)
Vegetation clearance	1 – 0.5
Asset repair/ maintenance works	0.5 – 0.1
Inspections/monitoring	2

Maintenance unit cost range	
£/km/year	
Low	High
800	15,000

Maintenance Standard - Maintain to target condition 4

Description of maintenance standard	
Maintenance activity	Frequency (times/year)
Vegetation clearance	0.5 – 0.2
Asset repair/ maintenance works	0.2 - 0.1
Inspections/monitoring	1

Maintenance unit cost range	
£/km/year	
Low	High
600	2,000

*Confidence Score** 1
**scale 1 low to 5 high, based on consideration of perceived confidence in source data, range of maintenance activities and potential impact of activity on condition*

Asset: Saltmarshes

Description of asset

Saltmarshes are, in effect, a transitional stage between mudflats and terrestrial habitat. They develop along sheltered coasts with soft, shallow shores which provide protection from strong wave action.

AIMS asset classification: Land// saltmarsh

Possible maintenance activities

Maintenance activity	Description
Vegetation clearance	Removal of young trees, shrubs and grass that may affect the structural integrity of the dune Environmental management (disposal of cleared vegetation)
Asset repair/ maintenance works	Installation of control structures, e.g. fences Replanting Creek management Vermin control Scour protection Replacing signs Repair of fencing
Inspections/monitoring	Visual inspection Habitat surveys Assessment of accretion/erosion trends

Assumptions: Standard built up from bottom-up consideration of activities, costs and frequencies

Factors influencing maintenance unit cost rate

Factors influencing maintenance costs	Weighting factor	Score	Weighted score
Exposed Environment	1		0

Maintenance standard and maintenance unit cost range

Maintenance Standard - Maintain to target condition 2

Description of maintenance standard	
Maintenance activity	Frequency (times/year)
Vegetation clearance	1 – 0.5
Asset repair/ maintenance works	0.5 – 0.2
Inspections/monitoring	2

Maintenance unit cost range	
£/km/year	
Low	High
1,000	10,000

Maintenance Standard - Maintain to target condition 3

Description of maintenance standard	
Maintenance activity	Frequency (times/year)
Vegetation clearance	0.5 – 0.2
Asset repair/ maintenance works	0.2 - 0.1
Inspections/monitoring	1

Maintenance unit cost range	
£/km/year	
Low	High
800	5,000

Maintenance Standard - Maintain to target condition 4

Description of maintenance standard	
Maintenance activity	Frequency (times/year)
Vegetation clearance	0.2
Asset repair/ maintenance works	0.03
Inspections/monitoring	0.5

Maintenance unit cost range	
£/km/year	
Low	High
600	1000

*Confidence Score** 1
**scale 1 low to 5 high, based on consideration of perceived confidence in source data, range of maintenance activities and potential impact of activity on condition*

Asset: Weirs

Description of asset

A small overflow dam across river or stream. A weir may be used to raise the water level upstream of the dam, to divert flow, or to control the water flow.

AIMS asset classification: Structure// weir

Possible maintenance activities

Maintenance activity	Description
Vegetation clearance	Removal of young trees, shrubs and grass that may affect the structural stability/integrity of the weir Environmental management (disposal of cleared vegetation)
Asset repair / maintenance works	Minor repair works to keep the asset in the required condition Minor concrete repair Sealant replacement Joint repair Vermin Control Scour protection Backfill replacement Replacing signs Repair of fencing
Desilting	Removal of silt from weir at specific locations Environmental management (removal of silt to be deposited off site at a licensed tip)
Reactive obstruction removal	Removal of debris from weir and channel Environmental management (off-site disposal of removed debris)
Operational and OPuS inspections	Visual inspection of structure Removal of small amounts of debris from weir Check if public safety measures are in place

Factors influencing maintenance unit cost rate

Factors influencing maintenance costs	Weighting factor	Score	Weighted score
Difficult access (e.g. site located far from a road, overhead power cables, protected sites, protected species etc.)	2		0
High river flow - making temporary damming difficult	2		0
Dredging Required	2		0
Location known for excessive fly tipping	1		0

Maintenance standard and maintenance unit cost range

Assumptions: Costs and frequency of maintenance activities are based upon engineered channel standard (EA FCRM Asset Management Maintenance Standards, Version 2010 (March))

Maintenance Standard - Maintain to target condition 2

Description of maintenance standard	
Maintenance activity	Frequency (times/year)
Vegetation clearance	1 - 2
Asset repair / maintenance works	1 - 2
Desilting	0.5 - 1
Reactive obstruction removal	1 - 2
Operational and OPuS Inspections	4 - 12

Maintenance unit cost range (all activities listed above) £/km/year			
incl Manual clearance		incl Mechanical clearance	
Low	High	Low	High
985	6,040	830	5,330

Maintenance Standard - Maintain to target condition 3

Description of maintenance standard	
Maintenance activity	Frequency (times/year)
Vegetation clearance	0.5 - 1
Asset repair / maintenance works	0.5 - 1
Desilting	0.2 – 0.5
Reactive obstruction removal	1
Operational and OPuS Inspections	1 - 4

Maintenance unit cost range (all activities listed above) £/km/year			
incl Manual clearance		incl Mechanical clearance	
Low	High	Low	High
580	2,730	500	2,375

Maintenance Standard - Maintain to target condition 4

Description of maintenance standard	
Maintenance activity	Frequency (times/year)
Vegetation clearance	0 - 0.5
Asset repair / maintenance works	0 - 0.5
Desilting	0
Reactive obstruction removal	0.5
Inspections	0.5

Maintenance unit cost range (all activities listed above) £/km/year			
incl Manual clearance		incl Mechanical clearance	
Low	High	Low	High
165	995	165	815

*Confidence Score** 4
**scale 1 low to 5 high, based on consideration of perceived confidence in source data, range of maintenance activities and potential impact of activity on condition*

Asset: Flap valves

Description of asset
Structures designed and manufactured for the control of water flow. Maintenance work will most probably be inspection driven

AIMS asset classification: Structure// control gate

Possible maintenance activities

Maintenance activity	Description
Vegetation clearance	Removal of young trees, shrubs and grass in surrounding area of asset that may cause obstruction Environmental management (disposal of cleared vegetation)
Asset repair / maintenance works	Minor repair works to keep the valve in the required condition Surface damage repair Fixing point repair Headwall repair Replacement of sealing Lubrication of moving parts Corrosion removal / protection Replacing signs
Reactive obstruction removal	Remove any debris by manual or mechanical means Environmental management (off-site disposal of removed debris)
Operational and OPuS inspections	Visual inspection of structure Removal of small amounts of debris/vegetation from valve Undertaking small maintenance tasks that do not require specialist equipment, materials or specific permits Check if public safety measures are in place

Factors influencing maintenance unit cost rate

Factors influencing maintenance costs	Weighting factor	Score	Weighted score
Difficult access (e.g. site located far from a road, overhead power cables, protected sites, protected species etc.)	2		0
Under designed or incorrectly placed screen	2		0
Heavy silt/debris load	2		0
Stand-alone maintenance activity	1		0

Maintenance standard and maintenance unit cost range

Assumptions: Assumed same frequency and maintenance costs as debris screens (EA FCRM Asset Management Maintenance Standards, Version 2010 (March))

Maintenance Standard - Maintain to target condition 2

Description of maintenance standard		
	Urban/suburban	Woodland/open public/open non-public
Maintenance activity	Frequency (times/year)	Frequency (times/year)
Operational and OPuS inspections	26 - 52	12 - 26
Reactive obstruction removal	2 - 4	2 - 3
Vegetation clearance	2 - 6	2 - 4
Asset repair / maintenance work	0.5	0.5

	Maintenance unit cost range (all activities listed above) £/valve/year			
	incl Manual clearance		incl Mechanical clearance	
Location	Low	High	Low	High
urban/suburban	1,460	7,020	1,760	7,600
woodland/open public/open non-public	860	4,160	1,150	4,600

Maintenance Standard - Maintain to target condition 3

Description of maintenance standard		
	Urban/suburban	Woodland/open public/open non-public
Maintenance activity	Frequency (times/year)	Frequency (times/year)
Operational and OPuS inspections	12 - 26	6 - 12
Reactive obstruction removal	2 - 3	1 -2
Vegetation clearance	1 - 4	1 -3
Asset repair / maintenance work	0.3 - 0.5	0.3 - 0.5

	Maintenance unit cost range (all activities listed above) £/valve/year			
	incl Manual clearance		incl Mechanical clearance	
Location	Low	High	Low	High
urban/suburban	760	4,160	1,060	4,600
woodland/open public/open non-public	440	2,550	590	2,810

Maintenance Standard - Maintain to target condition 4

Description of maintenance standard		
	Urban/suburban	Woodland/open public/open non-public
Maintenance activity	Frequency (times/year)	Frequency (times/year)
Operational and OPuS inspections	2 - 6	1 - 4
Reactive obstruction removal	0.2 - 1	0.2 - 1
Vegetation clearance	1 - 2	1
Asset repair / maintenance work	0 - 0.2	0 - 0.2

Location	Maintenance unit cost range (all activities listed above) £/valve/year

	incl Manual clearance		incl Mechanical clearance	
	Low	High	Low	High
urban/suburban	150	1,300	180	1,455
woodland/open public/open non-public	110	950	140	1,100

*Confidence Score** 4
**scale 1 low to 5 high, based on consideration of perceived confidence in source data, range of maintenance activities and potential impact of activity on condition*

Asset: Moveable Gates (penstocks and sluice gates) – Manual operation

Description of asset
Structures designed and manufactured for the control of water flow, manually operated. Maintenance work will most probably be inspection driven

AIMS asset classification: Structure// control gate

Possible maintenance activities

Maintenance activity	Description
Vegetation clearance	Removal of young trees, shrubs and grass in surrounding area of asset that may cause obstruction Environmental management (disposal of cleared vegetation)
Asset repair / maintenance works	Minor repair works to keep the gate in the required condition Surface damage repair Fixing point repair Headwall repair Replacement of sealing Lubrication of moving parts Corrosion removal / protection Replacing signs
Reactive obstruction removal	Remove any debris by manual or mechanical means Environmental management (off-site disposal of removed debris)
Operational and OPuS inspections	Visual inspection of structure Removal of small amounts of debris/vegetation from gate Undertaking small maintenance tasks that do not require specialist equipment, materials or specific permits Check if public safety measures are in place

Factors influencing maintenance unit cost rate

Factors influencing maintenance costs	Weighting factor	Score	Weighted score
Difficult access (e.g. site located far from a road, overhead power cables, protected sites, protected species etc.)	2		0
Under designed or incorrectly placed screen	2		0
Heavy silt/debris load	2		0
Stand-alone maintenance activity	1		0

Maintenance standard and maintenance unit cost range

Assumptions: Assumed same frequency and maintenance costs as debris screens (EA FCRM Asset Management Maintenance Standards, Version 2010 (March))

Maintenance Standard - Maintain to target condition 2

Description of maintenance standard		
	Urban/suburban	Woodland/open public/open non-public
Maintenance activity	Frequency (times/year)	Frequency (times/year)
Operational and OPuS inspections	26 - 52	12 - 26
Reactive obstruction removal	2 - 4	2 - 3
Vegetation clearance	2 - 6	2 - 4
Asset repair / maintenance work	0.5	0.5

	Maintenance unit cost range (all activities listed above) £/gate/year			
	incl Manual clearance		incl Mechanical clearance	
Location	Low	High	Low	High
urban/suburban	1,460	7,020	1,760	7,600
woodland/open public/open non-public	860	4,160	1,150	4,600

Maintenance Standard - Maintain to target condition 3

Description of maintenance standard		
	Urban/suburban	Woodland/open public/open non-public
Maintenance activity	Frequency (times/year)	Frequency (times/year)
Operational and OPuS inspections	12 - 26	6 - 12
Reactive obstruction removal	2 - 3	1 -2
Vegetation clearance	1 - 4	1 -3
Asset repair / maintenance work	0.3 - 0.5	0.3 - 0.5

	Maintenance unit cost range (all activities listed above) £/gate/year			
	incl Manual clearance		incl Mechanical clearance	
Location	Low	High	Low	High
urban/suburban	760	4,160	1,060	4,600
woodland/open public/open non-public	440	2,550	590	2,810

Maintenance Standard - Maintain to target condition 4

Description of maintenance standard		
	Urban/suburban	Woodland/open public/open non-public
Maintenance activity	Frequency (times/year)	Frequency (times/year)
Operational and OPuS inspections	2 - 6	1 - 4
Reactive obstruction removal	0.2 - 1	0.2 - 1
Vegetation clearance	1 - 2	1
Asset repair / maintenance work	0 - 0.2	0 - 0.2

	Maintenance unit cost rang(all activities listed above) £/gate/year			
	incl Manual clearance		incl Mechanical clearance	
Location	Low	High	Low	High
urban/suburban	150	1,300	180	1,455
woodland/open public/open non-public	110	950	140	1,100

*Confidence Score** 4
**scale 1 low to 5 high, based on consideration of perceived confidence in source data, range of maintenance activities and potential impact of activity on condition*

Asset: Moveable Gates (penstocks and sluice gates) – Electrical operation

Description of asset
Structures designed and manufactured for the control of water flow, electrically operated. Maintenance work will most probably be inspection driven

AIMS asset classification: Structure// control gate

Possible maintenance activities

Maintenance activity	Description
Vegetation clearance	Removal of young trees, shrubs and grass in surrounding area of asset that may cause obstruction Environmental management (disposal of cleared vegetation)
Asset repair / maintenance works	Minor repair works to keep the gate in the required condition Surface damage repair Fixing point repair Headwall repair Replacement of sealing Cleaning and repairing damaged elements / electric motor replacement Lubrication of moving parts Corrosion removal / protection Replacing signs
Reactive obstruction removal	Remove any debris by manual or mechanical means Environmental management (off-site disposal of removed debris)
Operational and OPuS inspections	Visual inspection of structure Removal of small amounts of debris/vegetation from gate Undertaking small maintenance tasks that do not require specialist equipment, materials or specific permits Check if public safety measures are in place

Factors influencing maintenance unit cost rate

Factors influencing maintenance costs	Weighting factor	Score	Weighted score
Difficult access (e.g. site located far from a road, overhead power cables, protected sites, protected species etc.)	2		0
Under designed or incorrectly placed screen	2		0
Heavy silt/debris load	2		0
Stand-alone maintenance activity	1		0

Maintenance standard and maintenance unit cost range

Assumptions: Assumed same frequency as Manual gates
Assumed Manual gate costs + 10%

Maintenance Standard - Maintain to target condition 2

Description of maintenance standard		
	Urban/suburban	Woodland/open public/open non-public
Maintenance activity	Frequency (times/year)	Frequency (times/year)
Operational and OPuS inspections	26 - 52	12 - 26
Reactive obstruction removal	2 - 4	2 - 3
Vegetation clearance	2 - 6	2 - 4
Asset repair / maintenance work	0.5	0.5

	Maintenance unit cost range (all activities listed above) £/gate/year			
	incl Manual clearance		incl Mechanical clearance	
Location	Low	High	Low	High
urban/suburban	1,606	7,722	1,936	8,360
woodland/open public/open non-public	946	4,576	1,265	5,060

Maintenance Standard - Maintain to target condition 3

Description of maintenance standard		
	Urban/suburban	Woodland/open public/open non-public
Maintenance activity	Frequency (times/year)	Frequency (times/year)
Operational and OPuS inspections	12 - 26	6 - 12
Reactive obstruction removal	2 - 3	1 -2
Vegetation clearance	1 - 4	1 -3
Asset repair / maintenance work	0.3 - 0.5	0.3 - 0.5

	Maintenance unit cost range (all activities listed above) £/gate/year			
	incl Manual clearance		incl Mechanical clearance	
Location	Low	High	Low	High
urban/suburban	836	4,576	1,166	5,060
woodland/open public/open non-public	484	2,805	649	3,091

Maintenance Standard - Maintain to target condition 4

Description of maintenance standard		
	Urban/suburban	Woodland/open public/open non-public
Maintenance activity	Frequency (times/year)	Frequency (times/year)
Operational and OPuS inspections	2 - 6	1 - 4
Reactive obstruction removal	0.2 - 1	0.2 - 1
Vegetation clearance	1 - 2	1
Asset repair / maintenance work	0 - 0.2	0 - 0.2

	Maintenance unit cost range (all activities listed above) £/gate/year			
	incl Manual clearance		incl Mechanical clearance	
Location	Low	High	Low	High
urban/suburban	165	1,430	198	1,600.5
woodland/open public/open non-public	121	1,045	154	1,210

*Confidence Score** 4

**scale 1 low to 5 high, based on consideration of perceived confidence in source data, range of maintenance activities and potential impact of activity on condition*

Asset: Flood Gates and Barriers

Description of asset

Floodgates and barriers are structures used to control water flow in reservoir, river, stream, or levee systems. They are closed at times of high water levels to prevent flooding. Maintenance works are generally a result of inspections.

AIMS asset classification: Structure// control gate

Possible maintenance activities

Maintenance activity	Description
Vegetation clearance	Removal of young trees, shrubs and grass in surrounding area of asset that may cause obstruction or impede operation Environmental management (disposal of cleared vegetation)
Asset repair / maintenance works	Minor repair works to keep the gate / barrier in the required condition Minor concrete repair Treatment of timber Replacement of components Surface damage repair Fixing point repair Sealant replacement Joint repair Cleaning and repairing damaged elements / electric motor replacement Lubrication of moving parts Corrosion removal / protection Replacing signs
Reactive obstruction removal	Remove any debris by manual or mechanical means Environmental management (off-site disposal of removed debris)
Operational and OPuS inspections	Visual inspection of structure Removal of small amounts of debris/vegetation from gate Undertaking small maintenance tasks that do not require specialist equipment, materials or specific permits Check if public safety measures are in place

Factors influencing maintenance unit cost rate

Factors influencing maintenance costs	Weighting factor	Score	Weighted score
Difficult access (e.g. site located far from a road, overhead power cables, protected sites, protected species etc.)	2		0
Under designed or incorrectly placed screen	2		0
Heavy silt/debris load	2		0
Stand-alone maintenance activity	1		0

Maintenance standard and maintenance unit cost range

Assumptions: Same costs as debris screens (EA FCRM Asset Management Maintenance Standards, Version 2010 (March)), with fewer inspections and other repairs but larger structures, hence same costs

Maintenance Standard - Maintain to target condition 2

Description of maintenance standard	
Maintenance activity	Frequency (times/year)
Vegetation clearance	2
Asset repair / maintenance works	2
Reactive obstruction removal	2
Operational and OPuS inspections	2

Maintenance unit cost range (all activities listed above) £/gate/year			
incl Manual clearance		incl Mechanical clearance	
Low	High	Low	High
1,460	7,020	1,760	7,600

Maintenance Standard - Maintain to target condition 3

Description of maintenance standard	
Maintenance activity	Frequency (times/year)
Vegetation clearance	1
Asset repair / maintenance works	1
Reactive obstruction removal	1
Operational and OPuS inspections	1

Maintenance unit cost range (all activities listed above) £/gate/year			
incl Manual clearance		incl Mechanical clearance	
Low	High	Low	High
760	4,160	1,060	4,600

Maintenance Standard - Maintain to target condition 4

Description of maintenance standard	
Maintenance activity	Frequency (times/year)
Vegetation clearance	0.5
Asset repair / maintenance works	0.5
Reactive obstruction removal	0.5
Operational and OPuS inspections	1

Maintenance unit cost range (all activities listed above) £/gate/year			
incl Manual clearance		incl Mechanical clearance	
Low	High	Low	High
150	1,300	180	1,455

*Confidence Score** 4
**scale 1 low to 5 high, based on consideration of perceived confidence in source data, range of maintenance activities and potential impact of activity on condition*

Evidence supporting the confidence scores

Asset Class	Confidence Score	Source of information	Reasons for grade
Vertical Timber Walls	4	Bottom-up, informed by existing vertical wall standards	Existing standard and detailed analysis, high confidence
Vertical Gabion Walls	3	Bottom-up, informed by existing vertical brick wall standards	Existing standard and detailed analysis, but limited maintenance activities available, variable response from asset
Sloping Walls (with turf protection)	4	Bottom-up, informed by existing embankment standards	Existing standard and detailed analysis, high confidence
Sloping Walls (impermeable/permeable)	4	Bottom-up, informed by existing vertical concrete wall standards	Existing standard and detailed analysis, high confidence
Demountable Defences – metal	3	Bottom-up analysis	Mid-range confidence assigned because no existing standard.
Demountable Defences - wood	3	Bottom-up analysis	Mid-range confidence assigned because no existing standard.
Beaches	1	Based on variety of regional schemes recycling and renourishment programmes	Highly variable costs and activities, difficult to generalise
Rock Groynes	2	Bottom-up analysis	Variable costs and activities, difficult to generalise
Timber Groynes	3	Used same costs as timber walls	Standard once removed from the information source (timber walls), therefore scores lower
Offshore Breakwaters	2	As for rock groynes	As for rock groynes
Dunes	1	Based on variety of regional schemes recycling and renourishment programmes	Highly variable costs and activities, difficult to generalise
Salt marshes	1	Bottom-up analysis	Highly variable costs and activities, difficult to generalise
Weirs	4	EA standard Engineered channel costs	Existing standard and detailed analysis, high confidence
Flap valves	4	EA standard Debris screens	Existing standard and detailed analysis, high confidence
Moveable Gates (Penstocks and Sluice Gates) – Manually operated	4	EA standard Debris screens	existing standard and detailed analysis, high confidence
Moveable Gates (Penstocks and Sluice Gates) – Electrically operated	4	EA standard Debris screens	Existing standard and detailed analysis, high confidence
Flood Gates and Barriers	4	EA standard Debris screens	Existing standard and detailed analysis, high confidence

We are The Environment Agency. It's our job to look after your environment and make it **a better place** – for you, and for future generations.

Your environment is the air you breathe, the water you drink and the ground you walk on. Working with business, Government and society as a whole, we are making your environment cleaner and healthier.

The Environment Agency. Out there, making your environment a better place.

Published by:

Environment Agency
Horizon House
Deanery Road
Bristol, BS1 5AH
Tel: 03708 506 506

Email: enquiries@environment-agency.gov.uk
www.environment-agency.gov.uk

Would you like to find out more about us, or about your environment?

Then call us on

08708 506 506* (Mon-Fri 8-6)

email

enquiries@environment-agency.gov.uk

or visit our website

www.environment-agency.gov.uk

incident hotline 0800 80 70 60 (24hrs)
floodline 0845 988 1188

* Approximate call costs: 8p plus 6p per minute (standard landline).
Please note charges will vary across telephone providers

Environment first: This publication is printed on recycled paper.