



Ayrshire Shoreline Management Plan

Appendix E: Economic Appraisal

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1 INTRODUCTION

1.1 BACKGROUND

A high level economic review of the actions proposed under the Ayrshire SMP has been carried out. This review included an assessment of potential economic damages to assets due to flooding and estimated potential economic benefits which may be avoided by implementing shoreline management.

Information developed by SEPA as part of the process of implementing the EU Floods Directive in Scotland was used to quantify the coastal flood risk along the Ayrshire shoreline.

Values of Average Annual Damage (AAD) were calculated based on the SEPA Flood Risk Appraisal Baseline National Coastal Receptor outputs. Direct and indirect damages to residential and non-residential properties were calculated following the Multi-Coloured Manual (MCM) methodology. Direct economic damages to roads associated with repair to carriageways as a result of flood water on road surface were also calculated. Impacted road section length combined with vehicle volume was considered as a proxy for indirect damages and disruption due to flooding.

The calculation of AADs was carried out in GIS. This calculation took the total direct and indirect damages for the receptors and calculated the predicted financial damages that would occur in any given year having due regard to the probability of any scale of flood event occurring in that year. The equation below was used to calculate annual average damages:

$$AAD = ([DMG10]+[DMG25])/2*((1/10)-(1/25)) + ([DMG25]+[DMG50])/2*((1/25)-(1/50)) + ([DMG50]+[DMG100])/2*((1/50)-(1/100)) + ([DMG100]+[DMG200])/2*((1/100)-(1/200)) + ([DMG200]+[DMG1000])/2*((1/200)-(1/1000)) + ([DMG1000]+[DMGInfin])/2*((1/1000)-0)$$

$$Infin = [DMG1000] + (([DMG1000] - [DMG200]) * (1/1000-0)/(1/200-1/1000))$$

Notes

- *DMG* is the total financial damages for a given return period, e.g. *DMG10* is the total direct and indirect damages for a 10 year flood event.
- *Infin* is the infinity value.

The economic factors that were included within the AAD calculations were as follows:

- **Coastal Flooding AADs**
 - For the coastal flood modelling the following receptor damages were used in the AAD calculation:
 - Residential Properties (Direct Damages, Indirect Damages and Emergency Services)
 - Non Residential Properties (Direct Damages and Emergency Services)
 - All **Road Damages** used in the AAD calculations were based on the flooded length of road (m) multiplied by the damage cost per length (£/km).

In order to calculate the potential additional economic benefit an action may have, Present Value Damages (PVD) were calculated for the receptors at risk. The PVD is the cumulative AAD taken over the lifetime of the project (assumed to be 100 years) discounted back to the present day. The discount rates are set by HM treasury and were 3.5% in years 1 to 30, 3% from years 31 to 75 and 2.5% from years 76 to 100. The potential additional economic benefit is equal to the PVD as this is the value of damage which may be prevented by implementing shoreline management actions.

It should be noted that the potential additional benefit quoted was the maximum available if all receptors were protected from flooding to a standard of protection of 1 in 200 years. It is also noted that the potential additional benefit calculated was based on the assets at risk due to coastal inundation only and did not include potential additional benefit due to coastal erosion risk and flood risk from wave overtopping, river or surface waters.

2 ECONOMIC APPRAISAL SUMMARY

2.1 SUB-CELL 6B1 ACTION PLAN: CLOCH POINT – HUNTERSTON ORE TERMINAL

Sub-cell	Total AAD	Policy Unit	Location reference	Action	Description	Target Timescale	Potential Estimated Cost	Potential Additional Benefit
6b1	£146,050	All	Skelmorlie to Hunterston Ore Terminal	Maintenance of existing defences.	Maintenance of coastal defences currently in place within this sub-cell. Regular condition monitoring should be undertaken and repairs carried out where necessary.	Ongoing	Existing Expenditure	N/A
				Detailed flood, erosion and wave overtopping feasibility study.	Evaluate the risk to the A78 and properties in Largs and Skelmorlie due to coastal flooding, erosion and wave overtopping. Determine and assess potential shoreline management options.	Short-term	Circa £150k	Circa £4,350,000 calculated based on tidal inundation

Sub-cell	Total AAD	Policy Unit	Location reference	Action	Description	Target Timescale	Potential Estimated Cost	Potential Additional Benefit
		6b1.1	Skelmorlie to Largs	Implement shoreline management to protect A78	Undertake shoreline management based on feasibility study to protect the A78 from coastal flooding and erosion.	Short to Medium-term	TBC based on feasibility study	
		6b1.2	Largs to Hunterston Ore Terminal	Implement shoreline management at Largs	Undertake shoreline management as per feasibility study to protect assets at Largs from coastal flooding, erosion and wave overtopping.	Short to Medium-term	TBC based on feasibility study	

2.2 SUB-CELL 6B2 ACTION PLAN: HUNTERSTON ORE TERMINAL – FARLAND HEAD

Sub-cell	Total AAD	Policy Unit	Location reference	Action	Description	Target Timescale	Potential Estimated Cost	Potential Additional Benefit
6b2	£1,045	All	Hunterston to Farland Head	Maintenance of existing defences.	Maintenance of coastal defences currently in place within this sub-cell. Regular condition monitoring should be undertaken and repairs carried out where necessary.	Ongoing	Existing Expenditure	N/A
				Flood and erosion feasibility study if required.	Carry out detailed assessment of the risk due to coastal flooding and erosion of any proposed development within sub-cell 6b2 and determine appropriate mitigation options for any proposed development.	As required	Circa £100k	Circa £31,000 calculated based on tidal inundation
		6b2.1	Hunterston	Implement shoreline management.	Undertake shoreline management as per feasibility study to protect new development if required.	As required	TBC based on feasibility study	

2.3 SUB-CELL 6C1 ACTION PLAN: FARLAND HEAD - ARDROSSAN

Sub-cell	Total AAD	Policy Unit	Location reference	Action	Description	Target Timescale	Potential Estimated Cost	Potential Additional Benefit
6c1	£8,721	All	Farland Head to Ardrossan	Maintenance of existing defences.	Maintenance of coastal defences currently in place within this sub-cell. Regular condition monitoring should be undertaken and repairs carried out where necessary.	Ongoing	Existing Expenditure	N/A
				Detailed flood, erosion and wave overtopping feasibility study.	Evaluate the risk to properties and Scottish Water assets within sub-cell 6c1 due to coastal flooding, erosion and wave overtopping. Determine and assess potential shoreline management options.	Short-term	Circa £150k	Circa £260,000 calculated based on tidal inundation

Sub-cell	Total AAD	Policy Unit	Location reference	Action	Description	Target Timescale	Potential Estimated Cost	Potential Additional Benefit
				Implement shoreline management.	Undertake shoreline management as per feasibility study to protect assets at risk due to coastal flooding, erosion and wave overtopping.	Short to Medium-term	TBC based on feasibility study	
				Manage risk to Scottish Water asset.	Undertake shoreline management as per feasibility study to protect Scottish Water assets.	Short to Medium-term	TBC based on feasibility study	

2.4 SUB-CELL 6C2 ACTION PLAN: ARDROSSAN - TROON

Sub-cell	Total AAD	Policy Unit	Location reference	Action	Description	Target Timescale	Potential Estimated Cost	Potential Additional Benefit
6c2	£309,713	6c2.4	Gailes Burn to Troon	Dune restoration.	Continue dune restoration works in this policy unit.	Ongoing	Existing Expenditure	N/A
		All	Ardrossan to Troon	Maintenance of existing defences.	Maintenance of coastal defences currently in place within this sub-cell. Regular condition monitoring should be undertaken and repairs carried out where necessary.	Ongoing	Existing Expenditure	N/A
				Detailed coastal flooding and erosion feasibility study.	Evaluate the risk to properties, Network Rail assets and private land within sub-cell 6c2 due to coastal flooding and erosion. Determine and assess potential shoreline management options.	Short-term	Circa £100K	Circa £9,230,000 calculated based on tidal inundation

Sub-cell	Total AAD	Policy Unit	Location reference	Action	Description	Target Timescale	Potential Estimated Cost	Potential Additional Benefit
6c2/ 6c3		6c2.4/ 6c3.1	Gailes Burn to Ayr	Detailed wave overtopping study.	Detailed study to evaluate the risk due to wave overtopping. Determine and assess options to manage flood risk due to wave overtopping at Troon.	Short-term	Circa £50k	
6c2		6c2.1	Ardrossan to Stevenston	Flood and erosion management at Saltcoats and Stevenston.	Undertake shoreline management to mitigate flood risk and control erosion at Saltcoats and Stevenston based on feasibility study.	Short to Medium- term	TBC based on feasibility study	
		6c2.2	Stevenston to Irvine Bay	Erosion management.	Undertake shoreline management to control erosion and prevent potential contamination based on feasibility study	Medium- term	TBC based on feasibility study	

Sub-cell	Total AAD	Policy Unit	Location reference	Action	Description	Target Timescale	Potential Estimated Cost	Potential Additional Benefit
		6c2.3	Irvine Bay to Gales Burn	Flood and erosion management along River Irvine and at Barassie.	Undertake shoreline management to mitigate flood risk adjacent to the River Irvine and to control erosion at Barassie/ Irvine beach park based on feasibility study.	Short to Medium-term	TBC based on feasibility study	
		6c2.4	Gales Burn to Troon	Flood management at Troon.	Undertake shoreline management to mitigate flood risk due to coastal inundation and wave overtopping to properties and other assets at Troon based on feasibility and wave overtopping studies.	Short to Medium-term	TBC based on feasibility study	

2.5 SUB-CELL 6C3 ACTION PLAN: TROON - AYR

Sub-cell	Total AAD	Policy Unit	Location reference	Action	Description	Target Timescale	Potential Estimated Cost	Potential Additional Benefit
6c3	£177,588	All	Troon to Ayr	Maintenance of existing defences.	Maintenance of coastal defences currently in place within this sub-cell. Regular condition monitoring should be undertaken and repairs carried out where necessary.	Ongoing	Existing Expenditure	N/A
				Detailed flood, erosion and wave overtopping feasibility study.	Evaluate the risk to properties and Scottish Water assets within sub-cell 6c3 due to coastal flooding, erosion and wave overtopping. Determine and assess potential shoreline management options.	Short-term	Circa £150k	Circa £5,290,000 calculated based on tidal inundation
				Erosion protection at Newton shore.	Undertake detailed design and implement erosion protection at Newton shore.	Short-term	TBC based on feasibility study	

Sub-cell	Total AAD	Policy Unit	Location reference	Action	Description	Target Timescale	Potential Estimated Cost	Potential Additional Benefit
				Flood and erosion management at Troon, Prestwick beach and Ayr	Undertake shoreline management to mitigate flood risk, control erosion and manage wave overtopping at Troon, Prestwick beach and Ayr based on feasibility study.	Short to Medium-term	TBC based on feasibility study	
				Manage risk to Scottish Water asset.	Undertake shoreline management as per feasibility study to protect Scottish Water assets.	Short to Medium-term	TBC based on feasibility study	

2.6 SUB-CELL 6C4 ACTION PLAN: AYR - DUNURE

Sub-cell	Total AAD	Policy Unit	Location reference	Action	Description	Target Timescale	Potential Estimated Cost	Potential Additional Benefit
6c4	£166,406	6c4.1	Ayr to Grenan Castle	Maintenance of existing defences.	Maintenance of coastal defences currently in place within this policy unit. Regular condition monitoring should be undertaken and repairs carried out where necessary.	Ongoing	Existing Expenditure	N/A
				Maintain South pier.	Continue maintenance of South Pier due to its importance for the port of Ayr.	Ongoing	Existing Expenditure	
				Detailed coastal flooding and wave overtopping feasibility study.	Detailed feasibility study to evaluate the risk due to coastal flooding at Ayr, Seafield and Doonfoot and to assess the risk due to wave overtopping along the promenade at south Ayr. Determine and assess potential shoreline management options.	Short-term	Circa £100k	Circa £4,960,000 calculated based on tidal inundation

Sub-cell	Total AAD	Policy Unit	Location reference	Action	Description	Target Timescale	Potential Estimated Cost	Potential Additional Benefit
				Flood and wave overtopping management at Ayr	Undertake shoreline management to mitigate flood risk and manage wave overtopping at Ayr, Seafield and Doonfoot based on feasibility study.	Short to Medium-term	TBC based on feasibility study	
		6c4.2	Grenan Castle to Dunure	Allow shoreline to function naturally.	No coastal defence measures are to be implemented in this policy unit. The shoreline will be allowed to revert to a natural state.	Short to Long-term	N/A	N/A

2.7 SUB-CELL 6C5 ACTION PLAN: DUNURE - TURNBERRY

Sub-cell	Total AAD	Policy Unit	Location reference	Action	Description	Target Timescale	Potential Estimated Cost	Potential Additional Benefit
6c5	£9,153	All	Dunure to Turnberry	Allow shoreline to function naturally.	No coastal defence measures are to be implemented in this policy unit. The shoreline will be allowed to revert to a natural state.	Short to Long-term	N/A	N/A

2.8 SUB-CELL 6C6 ACTION PLAN: TURNBERRY – BENNANE HEAD

Sub-cell	Total AAD	Policy Unit	Location reference	Action	Description	Target Timescale	Potential Estimated Cost	Potential Additional Benefit
6c6	£19,600	6c6.1	Turnberry to North Girvan	Allow shoreline to function naturally.	No coastal defence measures are to be implemented in this policy unit. The shoreline will be allowed to revert to a natural state.	Short to Long-term	N/A	N/A
		6c6.2/ 6c6.3	Girvan to Bennane Head	Maintenance of existing defences.	Maintenance of coastal defences currently in place within these policy units. Regular condition monitoring should be undertaken and repairs carried out where necessary.	Ongoing	Existing Expenditure	N/A

Sub-cell	Total AAD	Policy Unit	Location reference	Action	Description	Target Timescale	Potential Estimated Cost	Potential Additional Benefit
				Detailed coastal/ fluvial flooding and coastal erosion feasibility study.	Evaluate coastal/ fluvial flood risk from the Water of Girvan and Mill Burn and the coastal flood risk to the A77. Evaluate coastal erosion risk to Girvan Golf Course and the A77. Determine and assess potential shoreline management options.	Short-term	Circa £150k	Circa £540,000 calculated based on tidal inundation
		6c6.2	Girvan	Undertake erosion protection at Girvan Golf Course.	Undertake shoreline management to mitigate erosion risk at Girvan Golf Course based on feasibility study.	Short to Medium-term	TBC based on feasibility study	
				Undertake flood protection at Girvan.	Implement flood protection scheme at Girvan to protect against fluvial and coastal flooding based on feasibility study.	Short to Medium-term	TBC based on feasibility study	

Sub-cell	Total AAD	Policy Unit	Location reference	Action	Description	Target Timescale	Potential Estimated Cost	Potential Additional Benefit
		6c6.3	South Girvan to Bennane Head	Undertake flood and erosion protection for the A77.	Undertake shoreline management to mitigate flood and erosion risk to the A77 based on feasibility study.	Short to Medium-term	TBC based on feasibility study	

2.9 SUB-CELL 6D1 ACTION PLAN: BENNANE HEAD – CURRARIE PORT

Sub-cell	Total AAD	Policy Unit	Location reference	Action	Description	Target Timescale	Potential Estimated Cost	Potential Additional Benefit
6d1	£2,178	6d1.1	Bennane Head to Ballantrae	Maintenance of existing defences.	Maintenance of coastal defences currently in place within this policy unit. Regular condition monitoring should be undertaken and repairs carried out where necessary.	Ongoing	Existing Expenditure	N/A
				Coastal flood and erosion feasibility study.	Detailed assessment of the flood and erosion risk to the A77. Assessment of management options.	Short-term	Circa £100k	Circa £65,000 calculated based on tidal inundation
				Coastal flood and erosion protection.	Undertake shoreline management to protect the A77 from coastal flooding and erosion based on feasibility study.	Short-term	TBC based on feasibility study	

Sub-cell	Total AAD	Policy Unit	Location reference	Action	Description	Target Timescale	Potential Estimated Cost	Potential Additional Benefit
		6d1.2	Ballantrae to Currarie Port	Allow shoreline to function naturally.	No coastal defence measures are to be implemented in this policy unit. The shoreline will be allowed to revert to a natural state.	Short to Long-term	N/A	N/A

2.10 SUB-CELL 6D2 ACTION PLAN: CURRARIE PORT – MILLEUR POINT

Sub-cell	Total AAD	Policy Unit	Location reference	Action	Description	Target Timescale	Potential Estimated Cost	Potential Additional Benefit
6d2	£1,050	6d2.1	Currarie Port to Galloway Burn	Allow shoreline to function naturally.	No coastal defence measures are to be implemented in this policy unit. The shoreline will be allowed to revert to a natural state.	Short to Long-term	N/A	Circa £31,000 calculated based on tidal inundation

2.11 SUB-CELL A1 ACTION PLAN: LOCHRANZA – CLAUCHLANDS POINT

Sub-cell	Total AAD	Policy Unit	Location reference	Action	Description	Target Timescale	Potential Estimated Cost	Potential Additional Benefit
A1	£80,543	A1.2, A1.5	Lochranza to Sannox and Brodick to Cluchlands Point	Allow shoreline to function naturally.	No coastal defence measures are to be implemented in these policy units. The shoreline will be allowed to revert to a natural state.	Short to Long-term	N/A	N/A
		A1.1, A1.3, A1.4	Lochranza and Sannox to Brodick	Maintenance of existing defences.	Maintenance of coastal defences currently in place within these policy units. Regular condition monitoring should be undertaken and repairs carried out where necessary.	Ongoing	Existing Expenditure	N/A

Sub-cell	Total AAD	Policy Unit	Location reference	Action	Description	Target Timescale	Potential Estimated Cost	Potential Additional Benefit
				Integrated flood, erosion and wave overtopping feasibility study.	Undertake a detailed feasibility study to assess the risk due to flooding from all sources including coastal, fluvial, pluvial and groundwater at Lochranza. Assess coastal flood and erosion risk to the A841. Determine shoreline management options.	Short-term	Circa £175k	Circa £2,400,000 calculated based on tidal inundation
		A1.1	Lochranza	Flood protection at Lochranza.	Implement works to protect assets from coastal, fluvial, pluvial and groundwater flooding at Lochranza based on feasibility study.	Short to Medium-term	TBC based on feasibility study	
		A1.3	Sannox to Brodick	Flood and erosion protection for the A841.	Undertake shoreline management to protect the A841 from coastal flooding and erosion based on feasibility study.	Short to Medium-term	TBC based on feasibility study	

Sub-cell	Total AAD	Policy Unit	Location reference	Action	Description	Target Timescale	Potential Estimated Cost	Potential Additional Benefit
		A1.4	Brodick	Protect landfill site at Brodick.	Construct preferred option from Coast Protection Optioneering and Design Study for Brodick by AECOM in 2015 to protect landfill site. This consists of constructing two fishtail rock groynes extending from the shore at the southern extent of Brodick beach.	Short to Medium-term	£680,000-£985,000 (2015 costs)	

2.12 SUB-CELL A2 ACTION PLAN: CLAUCHLANDS POINT – KINGSCROSS POINT

Sub-cell	Total AAD	Policy Unit	Location reference	Action	Description	Target Timescale	Potential Estimated Cost	Potential Additional Benefit
A2	£115,359	A2.1, A2.3	Clauchlands Point to Kingscross Point (excluding Lamlash)	Allow shoreline to function naturally.	No coastal defence measures are to be implemented in these policy units. The shoreline will be allowed to revert to a natural state.	Short to Long-term	N/A	N/A
		A2.2	Lamlash	Maintenance of existing defences.	Maintenance of coastal defences currently in place within this policy unit. Regular condition monitoring should be undertaken and repairs carried out where necessary.	Ongoing	Existing Expenditure	N/A
				Coastal flood and erosion protection at Lamlash.	Undertake shoreline management to mitigate coastal flood and erosion risk at Lamlash based on feasibility study.	Short to Medium-term	TBC based on ongoing feasibility study	Circa £3,410,000 calculated based on tidal inundation

2.13 SUB-CELL A3 ACTION PLAN: KINGSCROSS POINT – DRUMADOON POINT

Sub-cell	Total AAD	Policy Unit	Location reference	Action	Description	Target Timescale	Potential Estimated Cost	Potential Additional Benefit
A3	£95,214	A3.1	Whiting Bay	Maintenance of existing defences.	Maintenance of coastal defences currently in place within this policy unit. Regular condition monitoring should be undertaken and repairs carried out where necessary.	Ongoing	Existing Expenditure	N/A
				Integrated flood and wave overtopping study.	Detailed assessment of the risk to assets in this policy unit due to coastal flooding, wave overtopping and drainage from fluvial and pluvial flooding. Assessment of flood risk management options.	Short-term	Circa £150k	Circa £2,710,000 calculated based on tidal inundation

Sub-cell	Total AAD	Policy Unit	Location reference	Action	Description	Target Timescale	Potential Estimated Cost	Potential Additional Benefit
				Flood and wave overtopping protection at Whiting Bay.	Undertake shoreline management to protect assets at Whiting Bay from coastal flooding, wave overtopping and drainage from fluvial and pluvial flooding based on feasibility study.	Short to Medium-term	TBC based on feasibility study	
		A3.2	Largymore to Drumadoon Point	Allow shoreline to function naturally.	No coastal defence measures are to be implemented in this policy unit. The shoreline will be allowed to revert to a natural state.	Short to Long-term	N/A	N/A

2.14 SUB-CELL A4 ACTION PLAN: DRUMADOON POINT - LOCHRANZA

Sub-cell	Total AAD	Policy Unit	Location reference	Action	Description	Target Timescale	Potential Estimated Cost	Potential Additional Benefit
A4	£23,655	A4.1	Drumadoon Point to Tormore	Allow shoreline to function naturally.	No coastal defence measures are to be implemented in this policy unit. The shoreline will be allowed to revert to a natural state.	Short to Long-term	N/A	N/A
		A4.2	Machrie Bay to Lochranza	Maintenance of existing defences.	Maintenance of coastal defences currently in place within this policy unit. Regular condition monitoring should be undertaken and repairs carried out where necessary.	Ongoing	Existing Expenditure	N/A
				Coastal flooding and erosion feasibility study.	Detailed assessment of the risk to assets in this policy unit due to coastal flooding and erosion. Assessment of flood risk management options.	Short-term	Circa £100k	Circa £705,000 calculated based on tidal

Sub-cell	Total AAD	Policy Unit	Location reference	Action	Description	Target Timescale	Potential Estimated Cost	Potential Additional Benefit
				Coastal flood and erosion protection.	Undertake shoreline management based on feasibility study to mitigate coastal flood and erosion risk.	Short to Medium-term	TBC based on feasibility study	inundation

2.15 SUB-CELL GREAT CUMBRAE ACTION PLAN

Sub-cell	Total AAD	Policy Unit	Location reference	Action	Description	Target Timescale	Potential Estimated Cost	Potential Additional Benefit
Great Cumbrae	£80,676	Great Cumbrae	Great Cumbrae	Maintenance of existing defences.	Maintenance of coastal defences currently in place within this policy unit. Regular condition monitoring should be undertaken and repairs carried out where necessary.	Ongoing	Existing Expenditure	N/A
				Millport flood scheme.	Construction of the flood scheme at Millport as proposed in the 2015 study. This scheme includes a harbour breakwater, flood walls and shore connected rock breakwaters.	Short-term	£12,446,000 (2015 costs)	Circa £2,405,000 calculated based on tidal inundation
				Coastal flooding feasibility study.	Detailed assessment of the coastal flood risk to roads to the north of the island. Assessment of flood risk management options.	Short-term	Circa £75k	

Sub-cell	Total AAD	Policy Unit	Location reference	Action	Description	Target Timescale	Potential Estimated Cost	Potential Additional Benefit
				Coastal flood protection for roads.	Undertake shoreline management to protect roads to the north of the island from coastal flooding based on feasibility study.	Short to Medium-term	TBC based on feasibility study	