Appendices

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Appendix A List of Stakeholders

List of Stakeholders

Category	Sub-grouping	Organisation
Decision makers	TDs and Senators	• Dublin North constituency • Dublin West constituency • Dublin North East constituency • Meath East constituency • Louth constituency
	Councillors	• Fingal Electoral Areas – Balbriggan – Malahide – Swords – Howth • Meath Electoral Areas – Dunshaughlin – Slane – Navan Area • Balbriggan Town Council • Louth Electoral Areas – Drogheda East – Drogheda West
Primary stakeholders	Local stakeholders	• Fingal County Council (FCC)* • Meath County Council (MCC)* • Office of Public Works* • DAFF* • Dublin Airport Authority • Dublin Airport Authority Stakeholders Forum • Iarnród Éireann • National Roads Authority • Meath County Development Board • Chambers of Commerce – Fingal • Chambers of Commerce – Meath • Irish Farmers Association
	Environmental organisations	• National Parks & Wildlife Service • Eastern Regional Fisheries Board • Eastern River Basin District Project
	SEA Environmental Authorities	• Environmental Protection Agency • Department of Environment, Heritage and Local Government (DEHLG) • Department of Communications, Energy and Natural Resources (DCENR)
Secondary stakeholders	Government Departments/Councils	• Department of Community, Rural and Gaeltacht Affairs • Department of Transport • Dublin City Council
	Community organisations	• FCC Community Forum (through the relevant Strategic Policy Committees) • Fingal Development Board • Meath Forum
	National organisations	• Fáilte Ireland • Electricity Supply Board • Marine Institute

Category	Sub-grouping	Organisation
		• Forest Service • Coillte Teoranta • Geological Survey of Ireland • Teagasc • An Garda Siochána
	Local business organisations	• Construction Industry Federation (CIF) • Meath County Enterprise Board • Fingal County Enterprise Board • Fingal Tourism • Meath Tourism • Dublin Airport Stakeholders Forum
	Environmental organisations	• Irish Wildlife Trust • Central Fisheries Board • Heritage Council • An Taisce • Birdwatch Ireland • Marine Institute • Landscape Alliance Ireland

Appendix B List of Objectives, indicators and targets

Core criteria		Objective		Sub-objective	Indicator	Minimum requirement	Aspirational target
1	Technical	a	Ensure flood risk management options are operationally robust		Level of operational risk of option i.e. mechanical or human intervention required (e.g. lengths/numbers of demountables, pumps etc	Manageable level of mechanical or human intervention.	No mechanical or human intervention.
		b	Minimise health and safety risk of flood risk management options	Reduce and where possible eliminate health and safety risks associated with the construction and operation of flood risk management options	Health and safety risk to construction workers and operators of flood risk management (FRM) options	Manageable level of health and safety risk.	No health and safety risk.
		c	Ensure flood risk managed effectively and sustainable into the future	Ensure flood risk management options are adaptable to future flood risk	Level of adaptability of FRM option to future flood	Option to be adaptable to the MRFS.	Option to be adaptable to the HEFS at negligible cost.
2	Economic	a	Minimise economic risk	Minimise economic risk	Average Annual Damage (AAD) (€)	No increase in economic risk	Economic risk reduced to zero
		b	Minimise risk to transport infrastructure	Minimise risk to transport infrastructure	Number of transport routes (road, rail, navigation) at risk from flooding (0.1% AEP Event)	No increase in number of transport routes at risk	Number of transport routes at risk reduced to 0
		c	Minimise risk to utility infrastructure	Minimise risk to utility infrastructure	Number of utility infrastructure assets (power stations, WWTWs, WTWs, telecom exchanges etc) at risk from flooding (0.1% AEP Event)	No increase in number of utility infrastructure assets at risk	Number of utility infrastructure assets at risk reduced to 0
		d	Manage risk to agricultural land		Area of agricultural land at risk of flooding [based on Corine land use classes] not benefiting from flood risk management measures	No increase in agricultural land at risk of flooding not benefiting from flood risk management measures	Risk to agricultural land at risk of flooding not benefiting from flood risk management measures reduced to 0
3	Social	a	Minimise risk to human health and life	Minimise risk to human health and life	Number of residential properties at risk from flooding (0.1% AEP Event)	No increase in number of properties	Number of properties reduced to 0
				Minimise risk to high vulnerability properties	Number of high vulnerability properties at risk from flooding (0.1% AEP event)	No increase in number of vulnerable properties	Number of properties reduced to 0
		b	Minimise risk to community	Minimise risk to social infrastructure	Number of high-value social infrastructural assets at risk from flooding (0.1% AEP Event)	No increase in number of assets	Number of assets reduced to 0

Core criteria		Objective		Sub-objective	Indicator	Minimum requirement	Aspirational target
				Minimise risk to employment	Number non-residential properties at risk from flooding (0.1% AEP Event)	No increase in non-residential properties at risk	Number of non-residential properties at risk reduced to 0
		c	Minimise risk to, or enhance, social amenity	Minimise risk to flood-sensitive social amenity sites	Number of flood-sensitive amenity sites at risk from flooding (0.1% AEP Event)	No increase in number of sites	Number of sites reduced to 0
4	**Environmental**	a	Support the objectives of the WFD	Prevent deterioration, and where possible improve, ecological status / potential of water-bodies	Ecological status of water-bodies	Provide no constraint associated with flood management measures to the achievement of good ecological status/potential	Significant contribution of flood risk management measures to the achievement of good ecological status/potential
				Prevent deterioration, and where possible improve, chemical status / potential of water-bodies	Chemical status of water-bodies	Provide no constraint associated with flood management measures to the achievement of good chemical status/potential	Significant contribution of flood risk management measures to the achievement of good chemical status/potential
		b	Minimise risk of environmental pollution	Minimise risk to potential sources of pollution	Number of potential pollution sources at risk from flooding (including those licensed under Directives 96/61/EC and 92/271/EC)	No increase in risk to potential pollution sources as a result of flood risk management measures	Reduction in risk potential pollution sources as a result of flood risk management measures
		c	Avoid damage to, and where possible enhance, the flora and fauna of the study area	Avoid damage to, and where possible enhance, internationally and nationally designated sites of nature conservation importance	Reported conservation status of designated sites relating to flood risk management	No deterioration in the conservation status of designated sites as a result of flood risk management measures	Improvement in the conservation status of designated sites as a result of flood risk management measures
				Avoid damage to or loss of, and where possible enhance, habitats supporting legally protected species and other known species and habitats of conservation concern	Presence of and/or extent and quality of suitable habitat supporting legally protected species and other known species of conservation concern (‘target species’)	No loss of extent or deterioration in quality of suitable habitat supporting target species	Increase in extent or improvement in quality of suitable habitat supporting target species as a result of flood risk management measures
				Avoid damage to or loss of existing riverine, wetland and coastal habitats and where possible create new habitat, to maintain a naturally functioning system	Area and quality of riverine, wetland and coastal habitat maintained or created/ restored as a result of flood risk management measures	No net loss of or permanent damage to existing riverine, wetland and coastal habitats as a result of flood risk management measures	Increase in extent of riverine, wetland and coastal habitats as a result of flood risk management measures
		d	Avoid damage to, and where possible enhance, fisheries within the catchment	Maintain existing, and where possible create new, habitat supporting fisheries and maintain upstream access	Area and quality of suitable habitat supporting salmonid and other fisheries and number of upstream barriers to fish passage	No net loss of suitable habitat for fisheries and provide no new upstream barriers to fish passage	Increase extent of suitable habitat for fisheries and improve existing upstream access for fish passage
				Ensure no adverse effects on designated Shellfish Waters	Classification status of shellfish waters	No deterioration in existing classification	Improve existing classification

Core criteria		Objective		Sub-objective	Indicator	Minimum requirement	Aspirational target
		e	Protect, and where possible enhance, landscape character and visual amenity within the catchment	Protect, and where possible enhance, landscape character, including designated highly sensitive landscapes, within the catchment	Compliance with landscape character objectives, including those of designated highly sensitive landscapes, relevant to flood risk management measures	No adverse changes in landscape character as a result of flood risk management measures	Improvements to landscape character as a result of flood risk management measures
				Protect, and where possible enhance, important views within the catchment	Quality of visual amenity at important views relevant to flood risk management measures	No adverse changes in visual amenity as a result of flood risk management measures	Improvements to visual amenity as a result of flood risk management measures
		f	Avoid damage to or loss of features of cultural heritage importance, their setting and heritage value within the study area	Avoid damage to or loss of known buildings, structures and areas of cultural heritage importance, including their setting and heritage value, within the study area	Numbers and types of internationally, nationally and locally designated areas, buildings, structures and features at risk from flooding	No damage to or loss of buildings, structures and features listed on the National Monuments Register, RMP, SMR, RPS and within ACAs, including their setting and heritage value, as a result of flood risk management measures; and/or No increase in flood risk for features sensitive to the impacts of flooding	Enhance the physical context and structure of water-based heritage features; and/or Reduction in flood risk for features sensitive to the impacts of flooding

Potentially significant environmental issues

Topic	Key Issues
Geology, soils and land use	Types of land use and management will influence flood risk
	Opportunities for habitat creation with potential losses of agricultural land
Water, morphology, fluvial and coastal processes	Strategic flood risk management options proposed by this study must not constrain the achievement of good ecological and chemical status/potential for all water bodies in the study area
	Flood risk management should not affect existing licensed discharges and abstractions, including drinking water
	Risks of pollution from flooding of landfills and other contaminated sites
Climate	Retain flexibility within proposed FRMP to adapt to unforeseen climate changes
Biodiversity, flora and fauna	Need to protect and, where possible, improve the conservation status of the European Sites, pNHAs and habitats and species of conservation concern within the study area
	Avoid disturbance to locally important habitats and species and ecological processes
Fisheries	Protect existing fisheries (fluvial, estuarine, coastal and shellfisheries) and seek opportunities to enhance the fisheries of the study area
	Maintain existing fisheries and identifying opportunities for improvements to fisheries and angling
	Avoid the creation of instream barriers to fish migration
Landscape and visual amenity	Avoid adverse impacts on visual amenity, landscape character and designated landscapes and seek opportunities for enhancement
Population and health	Reduce flood risk to people and property
	Reduce the physical and psychological impacts on the local population resulting from flood risk
	Maintain community infrastructure
	Reduce impacts on local economy
Development, infrastructure and material assets	Managing flood risk to/from existing and future development and infrastructure
	Understand how development pressure may influence changes in land use
Tourism and recreation	Manage flood risk to recreational, tourist and amenity facilities and identify opportunities for improvement
Archaeology and cultural heritage	Identify and manage flood risk to and impacts on known and unrecorded archaeological features in the study area

Appendix C Weighting of objectives and scoring of flood risk management options

Stage 3 - Local Weighting

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Core criteria		Objective		Sub-objective	Local weighting criteria
1	Technical	a	Ensure flood risk management options are operationally robust		Local weighting of 5 applied
		b	Minimise health and safety risk of flood risk management options	Reduce and where possible eliminate health and safety risks associated with the construction of flood risk management options	Local weighting of 5 applied
				Reduce and where possible eliminate health and safety risks associated with operation of flood risk management options	Local weighting of 5 applied
		c	Ensure flood risk managed effectively and sustainable into the future	Ensure flood risk management options are adaptable to future flood risk	Local weighting of 5 applied
2	Economic	a	Minimise economic risk	Minimise economic risk	5 = where annual average damages exceed €5 million 4 = where annual average damages are between €1 million and €4.99 million 3 = where annual average damages are between €0.5 million and €0.99 million 2 = where annual average damages are between €0.1 million and €0.49 million 1 = where annual average damages are less than €0.1 million 0 = where there are no annual average damages
		b	Minimise risk to infrastructure	Minimise risk to transport infrastructure	5 = where major transport infrastructure at risk, e.g. motorway, national rail route, national airport. 4 = where significant transport routes are at risk, e.g. National roadways. 3 = where regionally important infrastructure routes are at risk, Regional road network, regional airports. 2 = Where minor/local transport routes are at risk, e.g. secondary road network 1 = Where flood risk is likely to result in negligible impact, e.g. tertiary road network. 0 = No transport infrastructure at risk.
				Minimise risk to utility infrastructure	5 = where major utility infrastructure assets at risk, e.g. large power station, WWTW and WTP serving population equivalent (p.e) greater than 0.5 million. 4 = Where significant infrastructure assets at risk, e.g. WWTW and WTP serving a p.e greater than 100,000. 3 = Where medium infrastructure assets at risk, e.g. WWTW and WTP serving a population equivalent greater than 5000 2 = Where locally important infrastructure assets at risk, e.g. WWTW and WTP with p.e greater than 500 1 = Where minor infrastructure assets at risk, e.g. WWTW and WTP with p.e less than 500 0 = No infrastructure assets at risk.
		c	Manage risk to agricultural land		5 = where the area of agricultural land (not benefiting from FRM measures) at risk is greater than 500 hectares 4 = where the area of agricultural land (not benefiting from FRM measures) at risk is between 100 and 500 hectares 3 = where the area of agricultural land (not benefiting from FRM measures) at risk is between 50 and 99 hectares 2 = where the area of agricultural land (not benefiting from FRM measures) at risk is between 5 and 49 hectares 1 = where the area of agricultural land (not benefiting from FRM measures) at risk is less than 5 hectares 0 =where no agricultural land is at risk
3	Social	a	Minimise risk to human health and life	Minimise risk to human health and life	5 = Where the number of residential properties at risk of flooding is greater than 500 4 = Where the number of residential properties at risk of flooding is between 250 and 499 3 = Where the number of residential properties at risk of flooding is between 100 and 249 2 = Where the number of residential properties at risk of flooding is between 10 and 49 1 = Where the number of residential properties at risk of flooding is less than 10 0 = Where no residential properties are at risk of flooding
				Minimse risk to high vulnerability properties	5 = Where the number of high vulnerability properties at risk of flooding is greater than 25 4 = Where the number of high vulnerability properties at risk of flooding is between 11 and 24 3 = Where the number of high vulnerability properties at risk of flooding is between 6 and 10 2 = Where the number of high vulnerability properties at risk of flooding is between 2 and 5 7 = Where the number of high vulnerability properties at risk of flooding is equal to 1 0 = Where no high vulnerability properties are at risk of flooding
		b	Minimise risk to community	Minimise risk to social infrastructure	5 = where the number of high value social infrastructure assets (hospitals, schools, universities, fire stations, etc.) at risk of flooding is greater than 25 or where social infrastructure assets of major importance is at risk (i.e. National hospital) 4 = Where the number of high value social infrastructure assets at risk of flooding is between 11 and 25 or where social infrastructure asset of significant importance is at risk (i.e. regional hospital) 3 = Where the number of high value social infrastructure assets at risk of flooding is between 6 and 10 or where social infrastructure asset of medium importance is at risk (i.e. local hospital) 2 = where the number of high value social infrastructure assets at risk of flooding is between 2 and 5 or where social infrastructure asset of minor/local importance is at risk (i.e. local Garda station) 1 = Where the number of high value social infrastructure assets at risk of flooding is equal to 1

Stage 3 - Local Weighting

Core criteria		Objective		Sub-objective	Local weighting criteria
					0 = Where no social infrastructure assets are at risk.
				Minimise risk to employment	5 = where the number of commercial buildings at risk of flooding is greater than 500 4 = where the number of commercial buildings at risk is between 100 and 500 3 = where the number of commercial buildings at risk is between 50 and 99 2 = where the number of commercial buildings at risk is between 10 and 49 1 = where the number of commercial buildings at risk is less than 10 0 = Where no commercial buildings are at risk
		c	Minimise risk to, or enhance, social amenity	Minimise risk to flood-sensitive social amenity sites	5 = where the number of social amenity sites is greater than 25 4 = where the number of social amenity sites is between 11 and 25 3 = where the number of social amenity sites is between 6 and 10 2 = where the number of social amenity sites is between 2 and 5 1 = where the number of social amenity sites is equal to 1 0 = where no social amenity sites are at risk.
4	**Environmental**	a	Support the objectives of the WFD	Prevent deterioration, and where possible improve, ecological status / potential of water-bodies	5 = where the Water Framework Directive applies to waterbodies within the AU
				Prevent deterioration, and where possible improve, chemical status / potential of water-bodies	0 = where no waterbodies within the AU are identified under the Water Framework Directive
		b	Minimise risk of environmental pollution	Minimise risk to potential sources of pollution	5 = where there are licensed sites with high pollution potential at risk 0 = where there are no licensed sites with pollution potential at risk
		c	Avoid damage to, and where possible enhance, the flora and fauna of the study area	Avoid damage to, and where possible enhance, internationally and nationally designated sites of nature conservation importance	5 = where an internationally important site (e.g. SAC/SPA/Ramsar) is present and potentially affected 4 = where a nationally important site (NHA) is present and potentially affected 3 = where legally protected species/species of conservation concern are present/likely to be present and potentially affected 2 = where a site of local importance is present and potentially
				Avoid damage to or loss of, and where possible enhance, habitats supporting legally protected species and other known species and habitats of conservation concern	1 = where there are no designated sites or known records of legally protected species/species of conservation concern, but habitats are present that could be affected
				Avoid damage to or loss of existing riverine, wetland and coastal habitats and where possible create new habitat, to maintain a naturally functioning system	0 = no sites, habitats or species present that could be affected
		d	Avoid damage to, and where possible enhance, fisheries within the study area	Maintain existing, and where possible create new, habitat supporting fisheries and maintain upstream access	5 = where there are designated waters (e.g. under EU Shellfish Waters Directive; EU Freshwater Fish Directive) 4 = waterbody supports substantial salmonid fisheries/shellfisheries and is of national value for fishing/angling 3 = waterbody supports substantial fisheries/shellfisheries and is of regional value for fishing/angling 2 = waterbody supports fisheries/shellfisheries and is of local value for fishing/angling
				Ensure no adverse effects on designated Shellfish Waters	1 = fisheries could be present but unlikely given the modified nature of the channel/presence of barriers to movement; no known angling/fishing activities 0 = no fisheries or angling areas present
		e	Protect, and where possible enhance, landscape character and visual amenity within the study area	Protect, and where possible enhance, landscape character, including designated highly sensitive landscapes, within the catchment	5 = landscape designated as a internationally/nationally important landscape and potentially affected 4 = landscape character type designated at a county level as highly sensitive and/or exceptional/high value and potentially affected 3 = landscape character type designated at a county level as moderate sensitivity and/or medium value; protected views present that could be affected 2 = landscape character type designated at a county level as low sensitivity and/or low value and potentially affected 1 = no specific landscape sensitivity/value, but landscape features/views are important at a local level and potentially affected
				Protect, and where possible enhance, important views within the catchment	0 = no specific landscape designation, and no landscape value/sensitivity
		f	Avoid damage to or loss of features of cultural heritage importance, their setting and heritage value within the study area	Avoid damage to or loss of known buildings, structures and areas of cultural heritage importance, including their setting and heritage value, within the study area	5 = internationally important feature(s) (i.e. World Heritage Site) present and potentially affected 4 = nationally important feature(s) (e.g. National Monuments) present and potentially affected 3 = 5 or more sites/features listed on the RMP/RPS/SMR are present and potentially affected 2 = less than 5 sites/features listed on the RMP/RPS/SMR are present and potentially affected 1 = where no sites/features are at risk from flooding, but may be indirectly affected by the proposed works (e.g. setting) 0 = no sites/features at risk

Stage 3 - Scoring

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Objective		Score	Description						
Technical									
1a	Level of operational risk of option i.e. mechanical or human intervention required (e.g. lengths/numbers of demountables, pumps etc)	5	No mechanical or human intervention	or	accessible most of the time	or	Not reliant of telemetry or forecasting	or	No future maintenance requirements over life of option (say 50yrs)
		3	Limited mechanical or human intervention (say 25% reliant)	or	Inaccessible in flood conditions	or	Reliant on simple mechanical controls	or	Limited future maintenance requirements over life of option
		1	Medium mechanical or human intervention (say 50% reliant)	or	Restricted tidal access	or	Reliant on real time telemetry, not forecasted or modelled	or	Medium future maintenance requirements over life of option
		0	Significant mechanical or human intervention (say 75% reliant)	or	Difficult or long access (journey length > 2 hours)	or	Reliant on flood forecast certainty	or	Regular future maintenance required (say every 5 years)
		-1	All mechanical or human intervention	or	Inaccessible most of the time without new infrastructure	or	Reliant on flood forecast certainty yet certainty not available	or	Significant maintenance requirements
1b	Health and safety risk of FRM options	5	No health and safety risk to construction workers	or	No health and safety risk to operators of FRM options	or	No construction works carried out		
		3	Limited health and safety risk to construction workers	or	Limited health and safety risk to operators of FRM options	or	Minor works to flood defence infrastructure away from river channel, and minimal manual handling needed		
		1	Medium health and safety risk to construction workers	or	Medium health and safety risk to operators of FRM options	or	Works away from river channel, and avoiding trafficked areas with all heavy items able to be lifted mechanically		
		0	Significant health and safety risk to construction workers	or	Significant health and safety risk to operators of FRM options	or	Working in proximity to river channels, or near heavily trafficked routes, near services requiring diversion, large amounts of items		
		-1	Very significant health and safety risk to construction workers	or	Very significant health and safety risk to operators of FRM options	or	Extensive in channel working, requiring heavy plant, diving, BA confined space entry ,hot works, extensive service clashes		
1c	Level of adaptability of FRM option to future flood risk	5	Already meeting requirements of HEFS						
		3	Exceeds requirements of MRFS and adaptable to HEFS						
		1	Meets requirements of MRFS and adaptable to HEFS						
		0	Meets current requirements and adaptable to MRFS						
		-1	Only meets requirements of current risk and not adaptable						
Economic									
2a	Minimise economic risk	5	All economic damages removed						
		3	Significant reduction in economic damages						
		1	Limited reduction in economic damages						
		0	No increase in economic damages						
		-1	Potential for limited increase in economic damages						
		-3	Potential for increase in economic damages						
		-5	Potential significant increase in economic damages						
2b	Minimise risk to transport infrastructure	5	All transport routes (road, rail, navigation) protected from the risk of flooding.						
		3	Flood risk reduced to a significant number of transport routes						
		1	Flood risk reduced to a limited number of transport routes						
		0	No increase in the number of transport routes at risk of flooding.						
		-1	Potential for impacts on a limited number of transport routes (either directly or indirectly).						
		-3	Potential for impacts on a number of transport routes (either directly or indirectly).						
		-5	Potential for impacts on a significant number of transport routes (either directly or indirectly).						
2c	Minimise risk to utility infrastructure	5	All utility infrastructure assets (power stations, WWTWs, WTWs, telecom exchanges etc) protected from the risk of flooding.						
		3	Flood risk reduced to a significant number of utility infrastructure assets.						
		1	Flood risk reduced to a limited number of utility infrastructure assets.						
		0	No increase in the number of utility infrastructure assets at risk of flooding.						
		-1	Potential for impacts on a limited number of utility infrastructure assets (either directly or indirectly).						
		-3	Potential for impacts on a number of utility infrastructure assets (either directly or indirectly).						
		-5	Potential for impacts on a significant number of utility infrastructure assets (either directly or indirectly).						
2c	Manage risk to agricultural land not benefiting from FRM measures	5	All agricultural land not benefiting from FRM measures (non-irrigated arable land, pastures, land with complex cultivation and land principally occupied by areas of natural vegetation) protected from the risk of flooding.						
		3	Flood risk reduced to a significant area of agricultural land not benefiting from FRM measures.						
		1	Flood risk reduced to a limited area of agricultural land not benefiting from FRM measures.						
		0	No increase in the area of agricultural land at risk of flooding not benefiting from FRM measures.						
		-1	Potential for impacts on a limited area of agricultural land not benefiting from FRM measures (either directly or indirectly).						
		-3	Potential for impacts on an area of agricultural land not benefiting from FRM measures (either directly or indirectly).						
		-5	Potential for impacts on a significant area of agricultural land not benefiting from FRM measures (either directly or indirectly).						
Social									
3a	Minimise risk to human health and life	5	All residential properties protected from the risk of flooding. All high vulnerability properties protected from risk of flooding.						
		3	Flood risk reduced to a significant number of residential properties and to high vulnerability properties						
		1	Flood risk reduced to a limited number of residential properties and high vulnerability properties						
		0	No increase in the number of residential properties at risk of flooding and hih vulnerability properties						
		-1	Potential for impacts on a limited number of residential properties (either directly or indirectly) and high vulnerability properties						
		-3	Potential for impacts on a number of residential properties (either directly or indirectly) and high vulnerability properties.						
		-5	Potential for impacts on a significant number of residential properties (either directly or indirectly) and high vulnerability properties.						
3b	Minimise risk to community	5	All high-value social infrastructural assets, commercial businesses and industrial premises protected from the risk of flooding.						
		3	Flood risk reduced to a significant number of high-value social infrastructural assets, commercial businesses and industrial premises.						
		1	Flood risk reduced to a limited number of high-value social infrastructural assets, commercial businesses and industrial premises.						
		0	No increase in the number of high-value social infrastructural assets, commercial businesses and industrial premises at risk of flooding.						
		-1	Potential for impacts on a limited number of high-value social infrastructural assets, commercial businesses and industrial premises (either directly or indirectly).						
		-3	Potential for impacts on a number of high-value social infrastructural assets, commercial businesses and industrial premises (either directly or indirectly).						
		-5	Potential for impacts on a significant number of high-value social infrastructural assets, commercial businesses and industrial premises (either directly or indirectly).						
3c	Minimise risk to, or enhance, social amenity	5	All flood sensitive social amenity sites protected from the risk of flooding.						
		3	Flood risk reduced to a significant number of flood sensitive social amenity sites.						
		1	Flood risk reduced to a limited number of flood sensitive social amenity sites.						
		0	No increase in the number of flood sensitive social amenity sites at risk of flooding.						
		-1	Potential for impacts on a limited number of flood sensitive social amenity sites (either directly or indirectly).						
		-3	Potential for impacts on a number of flood sensitive social amenity sites (either directly or indirectly).						
		-5	Potential for impacts on a significant number of flood sensitive social amenity sites (either directly or indirectly).						

Objective		Score	Description
			Environmental
4a	Support the objectives of the WFD	5	Significant contribution of flood risk management measures to the achievement of good ecological status/potential by 2015.
		3	Contribution of flood risk management measures to the achievement of good ecological status/potential by 2015.
		1	Potential to provide opportunities to aid the achievement of good ecological status/potential by 2015.
		0	Provide no constraint associated with flood management measures to the achievement of good ecological status/potential by 2015.
		-1	Potential constraint to the achievement of good ecological status as proposed works over short stretches of river/estuary.
		-3	Potential constraint to the achievement of good ecological status as proposed works over longer stretches of river/estuary.
		-5	Significant constraint to the achievement of good ecological status.
4b	Minimise risk of environmental pollution	5	Potentially polluting sites protected from flooding
		3	Potential for a moderate reduction in flood risk to potentially polluting sites.
		1	Potential for a minor reduction in flood risk to potentially polluting sites.
		0	No positive or negative change in risk to potentially polluting sites.
		-1	Potential for a minor increase in flood risk to potentially polluting sites.
		-3	Potential for a moderate increase in flood risk to potentially polluting sites.
		-5	Potential for a significant increase in flood risk to potentially polluting sites.
4c	Avoid damage to, and where possible enhance, the flora and fauna of the study area	5	Improvement in conservation status of designated sites; increase in population sizes and/or extent of suitable habitat supporting target species; and/or, increase in extent of riverine, wetland and coastal habitats.
		3	Potential for habitat enhancement within designated sites.
		1	Potential for localised habitat enhancement.
		0	No deterioration in the conservation status of designated sites; no net decrease in population sizes of and/or loss of extent of suitable habitat supporting target species; and/or, no net loss of or permanent damage to existing riverine, wetland and coastal habitats.
		-1	Potential for impacts on designated sites and their features, and/or damage to and/or loss of existing riverine, wetland and coastal habitats and associated species, although limited by the already modified nature of the channel/shoreline or by the localised nature of the option.
		-3	Potential for impacts on designated sites and their features, and/or damage to and/or loss of existing riverine, wetland and coastal habitats and associated species.
		-5	Potential for a significant affect on designated sites which may lead to deterioration of the conservation status; significant loss of habitats and associated species.
4d	Avoid damage to, and where possible enhance, fisheries within the catchment	5	Increase extent of suitable habitat for fisheries and improve existing upstream access; increase length of waterside accessible for fishing; and/or, improve classification of shellfish waters.
		3	Potential for enhancement of recreational fishing areas and fisheries habitat.
		1	Potential for enhancement of recreational fishing areas.
		0	No net loss of suitable habitats for fisheries and provide no new upstream barriers to fish movement; maintain existing length of waterside accessible for fishing; and/or no deterioration in classification for shellfish waters.
		-1	Potential loss of/disturbance to riverine/estuarine habitat and dependent fisheries.
		-3	Localised loss and widespread disturbance to riverine/estuarine habitat and associated fisheries.
		-5	Significant loss of suitable habitat for fisheries; potential for deterioration in classification for shellfish waters, significant loss of waterside accessible for fishing.
4e	Protect, and where possible enhance, landscape character and visual amenity within the catchment	5	Contribute to existing or new areas of attractive, vibrant, accessible and safe waterway corridors within urban areas; and/or, improvement to visual amenity into/from designated areas.
		3	Opportunities identified to enhance visual amenity and landscape character in the wider area.
		1	Opportunities identified to enhance visual amenity and landscape character in the local area.
		0	No adverse impacts on landscape character; and/or, no deterioration in quality of views into/from designated areas.
		-1	Adverse change in local landscape character, although severity of impact reduced by use of demountables or low height of defences, impact is temporary, the fact that existing defences already exist in this area or landscape is designated as being of low sensitivity.
		-3	Adverse change in local landscape character within a landscape designated as being of medium to high sensitivity.
		-5	Significant adverse change in landscape character across a wide area; significant change in views into/from landscapes designated as being of medium to high sensitivity.
4f	Avoid damage to or loss of features of cultural heritage importance, their setting and heritage value within the catchment	5	Enhance the physical context and structure of water-based heritage features; reduce flood risk to features sensitive to the impacts of flooding; and/or, contribute to the understanding of context of water-based features listed on the RMP.
		3	Risk to a number of heritage features reduced.
		1	Risk to a limited number of heritage features reduced.
		0	No impact on heritage features; and/or, no increase in flood risk to features sensitive to the impacts of flooding.
		-1	Potential for impacts on a limited number of heritage features (either directly or indirectly).
		-3	Potential for impacts on a number of heritage features (either directly or indirectly).
		-5	Potential for impacts on a significant number of heritage features (either directly or indirectly).

Appendix D Option description sheets

Study Area

Assessment units	Fingal East Meath Study Area
Water bodies	Fingal and Meath coastline, Mayne River, Sluice River, Gaybrook Stream, Broadmeadow River, Ward River, Lissenhall Stream, Turvey River, Ballyboghil River, Corduff River, Baleally Stream, Bride's Stream, Jones's Stream, Rush Town Stream, St. Catherine's Stream, Mill Stream, Bracken River, Delvin River, Mosney Stream, Nanny River and Brookside stream
Preferred Flood risk management options	Proactive maintenance

Flood Risk (1% fluvial/0.5% tidal AEP event)

A total of 311 properties in the study area are at risk of flooding from the 1% fluvial/0.5% tidal AEP events, of which 295 incur economic damages as a result of that flooding. The results indicate that there are a relatively limited number of locations within the study area that are at significant risk of flooding. The main flood risk occurs along the coastline where some properties are at risk from both fluvial and tidal flooding. Fluvial flood risk can be increased in this area due to difficulties in rivers discharging to the sea during high tides. Flooding occurs on many of the watercourses due to under capacity structures. This flood risk can be exacerbated if structures or trash screens become blocked during flood events. However, the baseline case does not consider the flood risk due to blockage. Seven IRRs have been identified in the study area including two roads, three wastewater treatment works, one wastewater pumping station and one utility asset (Eircom, Bord Gais or ESB).

Properties		Utility assets (No.)	Transport routes (length km)	Agricultural land (hectares)	Social amenity sites (No.)
Residential (No.)	Non-residential (No.)				
248	65	6	6.4	1316	13

Environmental features and receptors at risk or present in the study area

- 51 river water bodies: 9 = high status; 3 = good status; (no deterioration required); 14 = moderate status; 23 = poor status; 3 = bad status (improvements required)
- 4 transitional (i.e. estuarine) water bodies: 4 = moderate status
- 4 coastal water bodies: 2 = high status; 2 = moderate status
- 4 Wastewater treatment works
- 35 Waste Management Permit Sites
- 22 Section 4 licences and 34 Section 16 licences in the study area
- 13 internationally designated sites and 17 nationally designated sites
- 57 sites on SMR/RPS/RMP registers at risk

Description of option

This option involves the development (Meath County Council (MCC)) and enhancement (Fingal County Council (FCC)) of a proactive maintenance regime targeting potential culvert blockage locations along the watercourses in the study area. It should be noted that the ownership and viability of this option is currently

under discussion at national level as it places additional duty on Local Authorities which may not have the resources or the legal ability to implement this option. FCC currently carries out maintenance at approximately 20 locations at risk of flooding in Fingal. This involves the cleaning of screens on a two to three week basis, with the frequency increased when heavy rain is forecast. A limited maintenance regime is carried out by MCC. This option would involve including additional culverts as part of the FCC proactive maintenance regime and setting out a proactive maintenance regime for culverts in MCC. Proactive maintenance would involve the removal of debris (vegetation, silt, rubbish) at the entrance and exit of culverts on a regular basis (i.e. monthly) and in advance of, and subsequent to, a flood event. This option would also involve the monitoring of culverts prone to blockages during a flood event. FCC currently uses weather forecast information to identify when a flood is likely. There is an opportunity to link this option to the FFWS identified for the following analysis units (Broadmeadow and Ward, Nanny and Delvin, Mayne and Sluice and Coastal).

Hydraulic modelling indicates that properties in the following locations are at risk due to culvert blockages (based on a comparison of flood maps for the 1% AEP fluvial event against the 70% culvert blockage flood maps for the 1% AEP event): Swords, Dardistown, Balgriffin, Portmarnock Bridge, Warbelstown, Ashbourne, Ratoath, Ballyboghil, Skerries and Bettystown.

Potential impact on principal overland flow routes and areas of significant natural floodplain storage

As this option is focused on reducing the risk of blockage of trash screens and structures it does not impact on principal overland flow routes other than to reduce out of bank flooding caused by blockage. This option does not involve the construction of any structures in the floodplain and therefore does not in any way affect areas of significant natural floodplain storage.

Multi Criteria Analysis (MCA) Results – option 1

Benefit Cost Ratio (BCR)		MCA scores				
Benefits of option	€1,483k	Technical	Economic	Social	Environmental	**Overall**
Cost of option	€1,686k	-25	145	150	75	**345**
BCR	0.88					

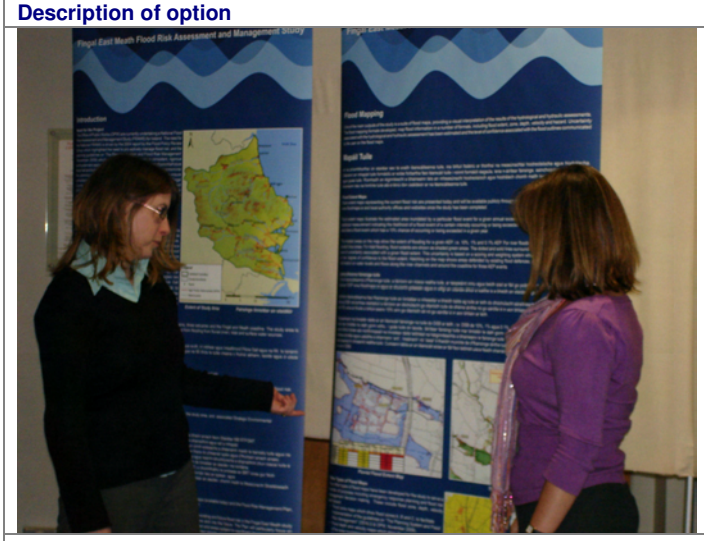
SEA Conclusions and recommendations

Maintenance works within the river channels, estuaries and to regularly unblock culverts would have only limited effects on the potentially sensitive riverine and estuarine habitats, flora and fauna at these locations owing to their temporary nature and localised scale. No changes to the current flooding and tidal regime and hydrology are anticipated, except when the volume and speed of flows are temporarily increased following the removal of blockages. It is, therefore, concluded that there is no potential for significant effects.

Details of the assessment are provided in the SEA ER.

Assessment units	Fingal East Meath Study Area
Water bodies	Fingal and Meath coastline, Mayne River, Sluice River, Gaybrook Stream, Broadmeadow River, Ward River, Lissenhall Stream, Turvey River, Ballyboghil River, Corduff River, Baleally Stream, Bride's Stream, Jones's Stream, Rush Town Stream, St. Catherine's Stream, Mill Stream, Bracken River, Delvin River, Mosney Stream, Nanny River and Brookside stream
Preferred Flood risk management options	Targeted public awareness and preparedness campaign combined with IPFP

Description of option



The targeted public awareness and preparedness campaign is necessary to educate the public of the risk of flooding to their properties and the protection methods available to them to reduce potential damage from flood events (i.e. IPFP measures). Information would be disseminated through the distribution of information leaflets, FEM FRAMS website and the provision of public information days.

IPFP involves the use of 'off the shelf' flood defence products to provide individual flood protection to residential and commercial properties. Such products include flood gates, flood barriers, air vent blocks and the installation of non return valves to service pipes. The level of protection afforded by individual property protection is dependant on a number of factors including the uptake, advance warning of flood risk and depth of flooding. For the purposes of assessment, it is assumed that this measure is only applicable when the depth of flooding at a property is less than 0.6m.

The BCR for this option is 0.85 and is based on an assumed 20% reduction in economic risk. The benefits of this option would be significantly greater if the option was provided with a FFWS. Details of the FFWS are detailed in the following Analysis Units (Broadmeadow and Ward, Nanny and Delvin, Mayne and Sluice and Coastal). The BCR for this option when combined with a FFWS is 2.96.

Potential impact on principal overland flow routes and areas of significant natural floodplain storage

This option will not alter existing overland flood routes or impact on areas of significant natural flood plain storage.

Multi Criteria Analysis (MCA) Results

Benefit Cost Ratio (BCR)		MCA scores				
Benefits of option	€3,492k	Technical	Economic	Social	Environmental	**Overall**
Cost of option	€4,127k	50	75	0	0	**125**
BCR	0.85	A greater BCR can be achieved if the FFWS options in the analysis units are				

	(2.96 with FFWS)	implemented. Having FFWS will increase the likelihood of IPFP being put in place before the flood event and therefore increase the benefits achieved by this option.

SEA Conclusions and recommendations

The implementation of a public awareness and education campaign would not involve or result in any physical/ environmental change to the *Natura 2000* sites beyond the baseline situation. The installation of flood protection measures for individual properties would be located beyond the water bodies, and it is assumed that these will be installed in already modified areas. It is, therefore, concluded that there is no potential for significant effects.

Details of the assessment are provided in the SEA ER.

Nanny and Delvin AU

Assessment units	Nanny and Delvin AU
Water bodies	Nanny, Delvin
Preferred flood risk management option	Flood forecasting and warning system for the Nanny River

Flood Risk (1% AEP event)

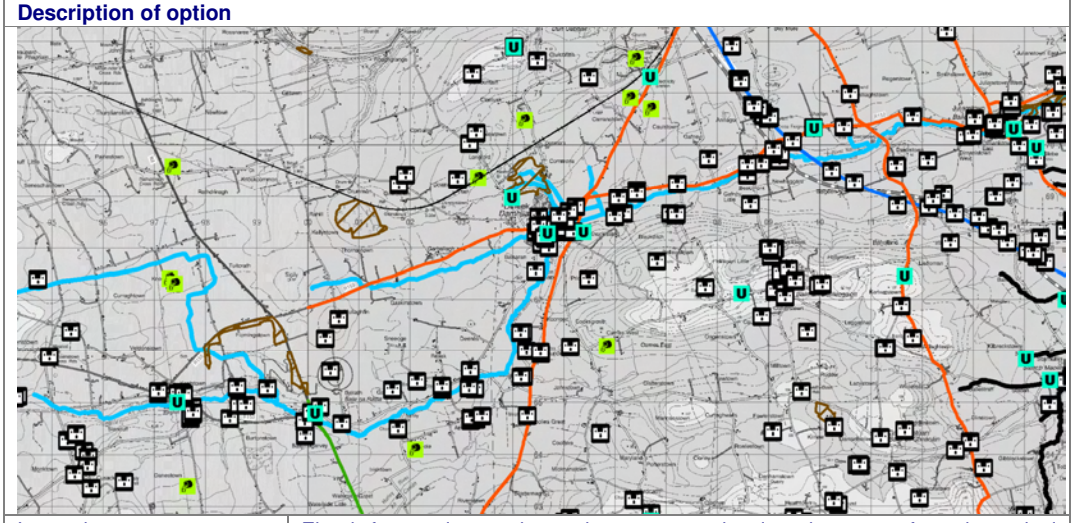
There is limited economic flood risk for the 1% AEP event, with the majority of the risk along the Nanny River. There is a small cluster of properties at risk of flooding at Beaumont Bridge, with the remainder of the risk limited to isolated properties along the rivers. One IRR has been identified in the Nanny and Delvin AU, a utility asset at Stamullin.

Properties		Utility assets (No.)	Transport routes (length km)	Agricultural land (hectares)	Social amenity sites (No.)
Residential (No.)	Non-residential (No.)				
15	5	2	1.5	485	0

Environmental features and receptors at risk or present in the study area

- 13 river water bodies: 7 = moderate status; 6 = poor status
- 2 Waste Management Permit Sites
- 4 Section 4 licences
- Duleek Commons pNHA; Thomastown Bog pNHA; Balrath Woods pNHA; and Cromwell's Bush Fen pNHA
- 71 sites listed on Meath County Council's Wetland Inventory
- 11 sites on RPS/RMP/SMR at risk

Description of option



Legend

Flood forecasting and warning systems involve the use of mathematical computer models to predict flood water levels based on actual meteorological data and tools to disseminate flood hazard data to people at risk. Further information on the viability of various flood forecasting options are reported on in the Preliminary Options Report. Flood forecasts would be disseminated through a dedicated website and messaging service to provide advance warning to communities.

A FFWS for the Nanny River would provide advance flood warning to properties at risk along the Nanny River including properties in Duleek area APSR and properties in rural areas along the watercourse. The image above shows the Nanny River and flood risk indicators within the catchment of the Nanny River. Those indicators in the floodplain of the Nanny River are likely to benefit from the proposed FFWS. Further details are available in Appendix E4.

Potential impact on principal overland flow routes and areas of significant natural floodplain storage

This option would have no impact on either principal overland flow routes or areas of significant natural floodplain storage.

Multi Criteria Analysis (MCA) Results – option 1

Benefit Cost Ratio (BCR)		MCA scores				
Benefits of option	€557,071	Technical	Economic	Social	Environmental	**Overall**
Cost of option	€450,803	200	25	0	0	**225**
BCR	1.24 (4.94 with IPFP)	More benefit can be achieved from FFWS if it is implemented in conjunction with IPFP.				

SEA Conclusions and recommendations

The effects of this option on the SEA receptors in the Nanny River catchment would be neutral (where applicable), with no significant (i.e. moderate or major), minor positive or negative changes relative to the existing conditions

Details of the assessment are provided in the SEA ER.

Duleek area APSR

Assessment units	Duleek area APSR
Water bodies	Nanny, Paramadden
Preferred flood risk management option	Raising existing defence embankment to a higher standard of protection

Flood Risk (1% AEP event)

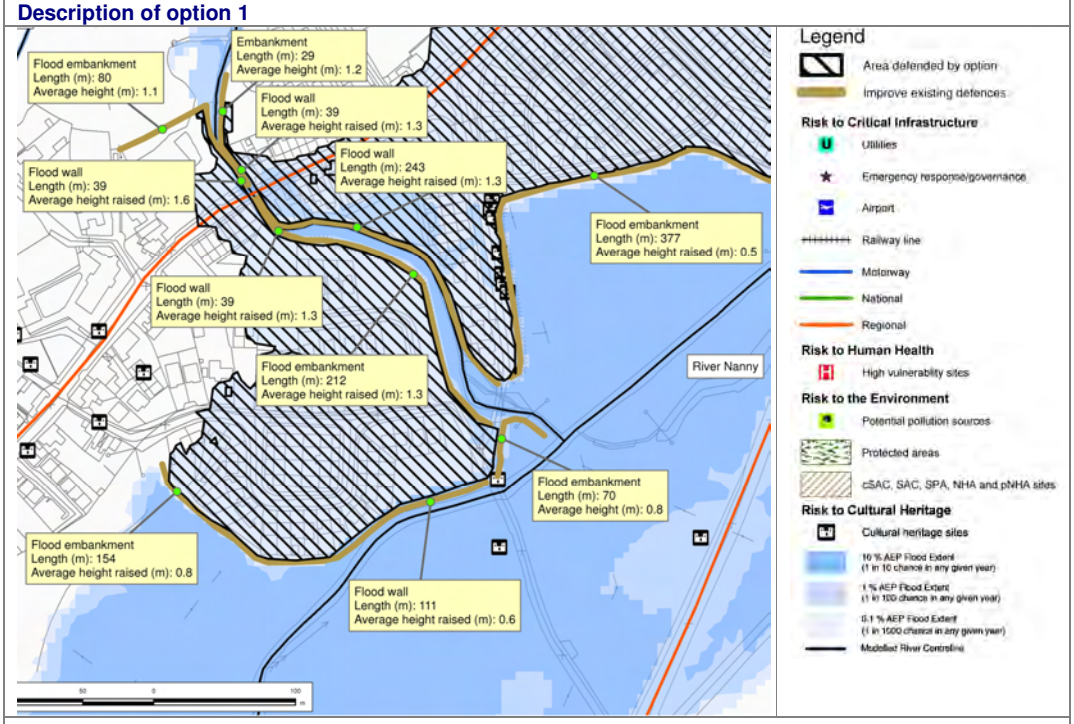
Duleek area APSR is at significant risk of flooding for events greater than the 1% AEP event due to overtopping of the flood defence embankments. The defences along the Nanny River and its tributary, the Paramadden are overtopped by events greater than the 1% AEP. Flooding from the 0.1% AEP affects 191 properties compared to just 5 properties for the 1% AEP event. Due to the significant level of the risk from the 0.1% AEP event, options were considered above the normal 1% AEP standard of protection.

Properties		Utility assets (No.)	Transport routes (length km)	Agricultural land (hectares)	Social amenity sites (No.)
Residential (No.)	Non-residential (No.)				
5 *191 (0.1% AEP)*	0 *0 (0.1% AEP)*	0	0.05	26	0

Environmental features and receptors present or at risk

- 2 river water bodies: 2 = poor status
- Duleek Commons pNHA and
- 26 sites listed on Meath County Council's Wetland Inventory
- 4 sites on RPS/RMP/SMR at risk

Description of option 1



This option involves raising existing flood defence embankments and walls in Duleek to provide protection up to the 0.1% AEP event. Hydraulic modelling indicates that some new defences would also be required as part of this option.

The existing flood defences at Duleek include embankments, walls, a pumping station and channel maintenance works. Hydraulic modelling indicates that these defences provide protection to the majority of properties in Duleek up to the 1% AEP event. The results from the hydraulic modelling indicate that the existing flood embankments would need to be raised by an average of 1.4m and that the existing flood walls would need to be raised by an average of 1.4m for the 0.1% AEP event. This option assumes that existing

flood defences are structurally sound to allow them to be raised to a higher standard of protection. Upstream of the bridge on the main street through Duleek, approximately 40m of new flood embankments are required along the left bank and 20m along the right bank of the Paramadden River. The average height of the embankments on the left bank is 1.2m and the average height of embankments on the right bank is 1m. The figure above shows the location where defences would need to be raised in Duleek. Further details are available in Appendix E4.

Hydraulic modelling indicates that there is a negligible impact on water levels along the Nanny River with this option. Along the Paramadden tributary, the construction of new defences and raising of existing defences has an impact on water levels. Water levels are raised by an average of 0.8m along a 0.5km stretch of the river channel. The maximum increase in water levels is 0.93m.

Potential impact on principal overland flow routes and areas of significant natural floodplain storage

This option has no impact on overland flow paths or significant natural flood plain storage as it involves modifying an existing flood defence scheme.

Multi Criteria Analysis (MCA) Results

Benefit Cost Ratio (BCR)		MCA scores				
Benefits of option	€2,934k	Technical	Economic	Social	Environmental	**Overall**
Cost of option	€2,747k	225	200	90	-140	**375**
BCR	1.07	Benefits up to the 0.1% AEP considered as proposed option is to protect up to the 0.1% AEP				

SEA Conclusions and recommendations

- Significant positive effects as a result of the reduction in flood risk to five residential properties and transport infrastructure (a 50m stretch of regional road);
- Significant negative effects on landscape character and visual amenity; and
- Minor negative effects on the achievement of WFD objectives; flora and fauna (including potential effects on designated sites downstream); fisheries and cultural heritage (effects on the setting of more than four features).

Details of the assessment are provided in the SEA ER.

Broadmeadow and Ward AU

Assessment units	Broadmeadow and Ward AU
Water bodies	Broadmeadow, Ward
Preferred flood risk management option	Flood forecasting and warning system for the Broadmeadow River

Flood Risk (1% AEP event)

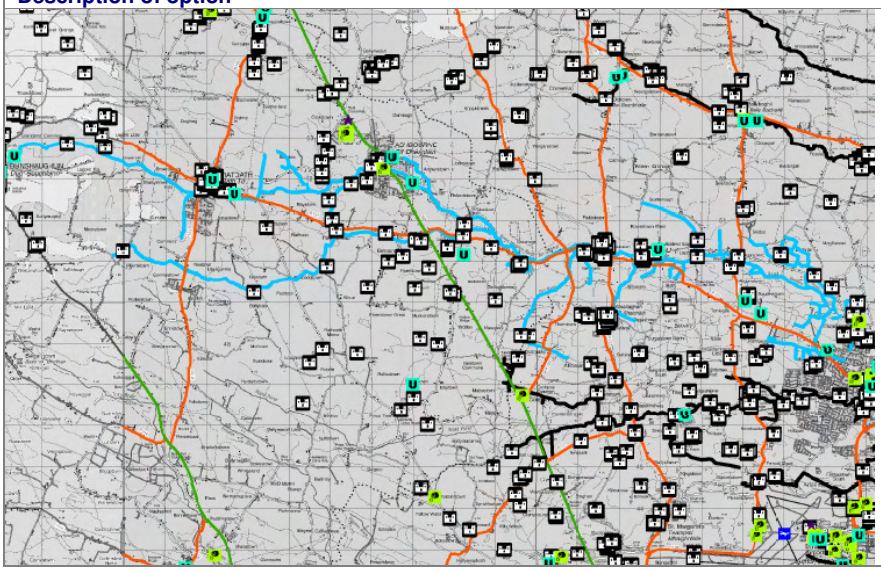
There is limited economic flood risk to properties in the AU for the 1% AEP event with the majority of the risk confined to small clusters of properties at Rowlestown East area APSR and Ratoath area APSR. The remainder of the risk is limited to isolated properties along the rivers. Two IRRs have been identified in the AU, wastewater treatment works at Ashbourne and Toberburr (in Owens Bridge APSR).

Properties		Utility assets (No.)	Transport routes (length km)	Agricultural land (hectares)	Social amenity sites (No.)
Residential (No.)	Non-residential (No.)				
18	0	2	0.5	150	4

Environmental features and receptors present or at risk

- 25 river water bodies: 4 = high status; 1 = good status; 5 = moderate status; 12 = poor status; 3 = bad status
- 1 Wastewater Pumping Station
- 8 Waste Management Permit Sites
- 4 Section 4 licences
- 13 sites on the SMR/RPS/RMP

Description of option



Flood forecasting and warning systems (FFWS) involve the use of mathematical computer models to predict flood water levels based on actual meteorological data and tools to disseminate flood hazard data to people at risk. Further information on the viability of various flood forecasting options are reported on in the Preliminary Options Report. Flood forecasts would be disseminated through a dedicated website and messaging service to provide advance warning to communities.

The image above shows the Broadmeadow River and flood risk indicators within the catchment of this river. Those indicators in the floodplain of the Broadmeadow River are likely to benefit from the proposed FFWS. In terms of at risk properties, a FFWS for the Broadmeadow River would provide advance flood warning to residential and commercial properties at risk in the Ratoath area APSR (9), Ashbourne area APSR (3), Rowlestown East area APSR (2), properties in rural areas along the watercourse (3) and the IRR in Ashbourne. It would not provide any benefit to the remaining at risk property along the Ward River. A FFWS for the Broadmeadow River would provide advance flood warning to residential and commercial properties at risk in the Ratoath area APSR (9), Ashbourne area APSR (3), Rowlestown East area APSR (2), properties in rural areas along the watercourse (3) and the IRR in Ashbourne. It would not provide any benefit to the remaining at risk property along the Ward River.

Potential impact on principal overland flow routes and areas of significant natural floodplain storage

This option has no impact on overland flow paths or significant natural flood plain storage.

Multi Criteria Analysis (MCA) Results

Benefit Cost Ratio (BCR)		MCA scores				
Benefits of option	€362,954	Technical	Economic	Social	Environmental	**Overall**
Cost of option	€450,803	200	25	0	0	**225**
BCR	0.81 (3.22 with IPFP)	More benefit can be achieved from FFWS if it is implemented in conjunction with IPFP (Study area option 2).				

SEA Conclusions and recommendations

The effects of this option on the SEA receptors in the Broadmeadow River catchment would be neutral (where applicable), with no significant (i.e. moderate or major), minor positive or negative changes relative to the existing conditions

Details of the assessment are provided in the SEA ER.

Ratoath area APSR

Assessment units	Ratoath area APSR
Water bodies	Broadmeadow
Preferred flood risk management option	Improving channel conveyance by replacing a bridge on the Broadmeadow River at the R125 Ratoath Road and replacing a culvert on a tributary of the Broadmeadow River.

Flood Risk (1% AEP event)

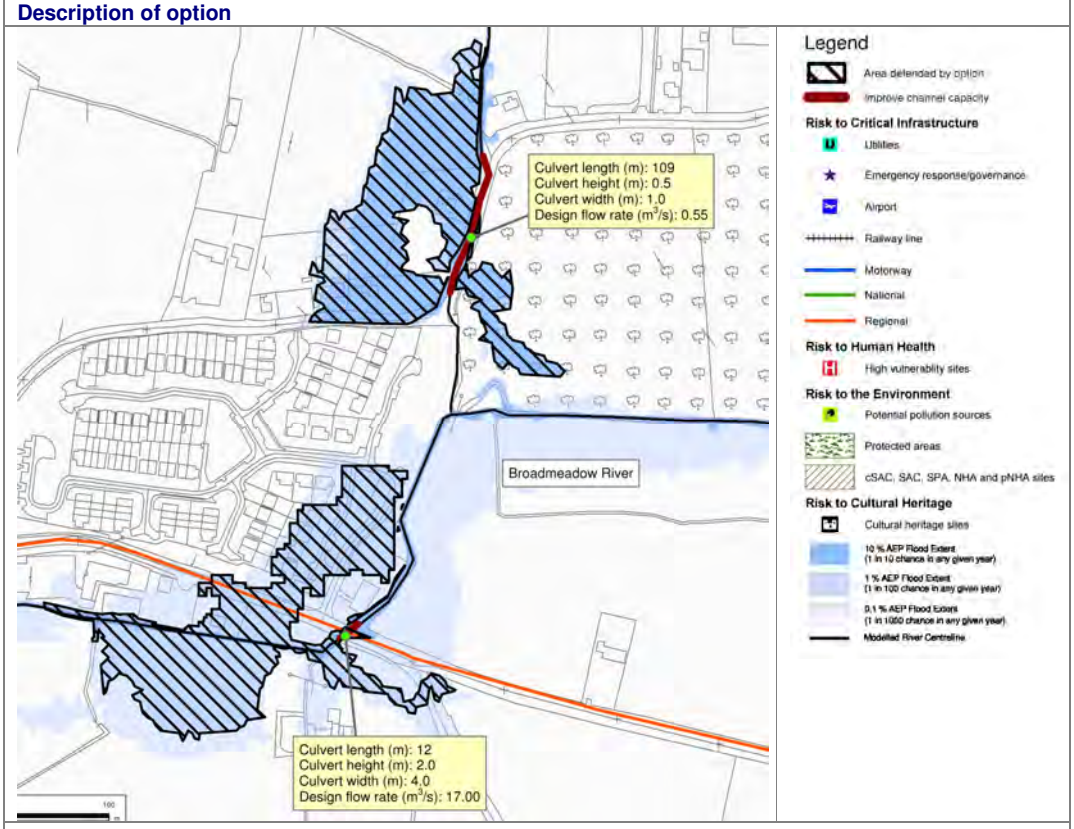
Flood risk in Ratoath Area APSR results form out of bank flooding along the Broadmeadow River primarily due to under capacity culverts under the R125 and along the Broadmeadow tributary to the north of the R125. Flood water spills out of bank upstream of the R123 culvert and floods a number of properties in the housing estate at Moulden Bridge. Existing flood defences (a flood embankment) protect a new housing estate at Somerville in the Ratoath area APSR.

Properties		Utility assets (No.)	Transport routes (length km)	Agricultural land (hectares)	Social amenity sites (No.)
Residential (No.)	Non-residential (No.)				
9	0	0	0.09	2.7	0

Environmental features and receptors present or at risk

- 3 river water bodies: 1 = good status; 2 = bad status

Description of option



This option involves replacing two structures where the existing capacity of the structures is insufficient to convey large flows and results in surcharging and spilling of flood waters. The option is slightly amended from the option proposed at Stage 2 following the modelling of this option. The modelling indicates that the proposed embankments identified at stage 2 are not required.

Modelling results indicate that a rectangular concrete culvert of 2m high by 4m wide would be sufficient to reduce flood risk at the R125 crossing. This culvert can convey a flow of 17m^3/s which equates to the 1% AEP MRFS 95%ile flow without surcharging. The replacement culvert on the Broadmeadow River tributary is also designed to convey the 1% AEP MRFS 95%ile flow without surcharging. The dimensions for this culvert are

0.5m high by 1m wide by 109m in length and has a capacity of 0.6m^3/s. Due to the sizing of the culverts the 0.1% AEP flood extent will be significantly reduced. The figure above shows the location where the culvert capacity needs to be increased. Further details are available in Appendix E1.

Modelling results indicate that this option will have negligible impact on water levels upstream and downstream of the proposed location for this option. Changes in water levels are localised (i.e. along a 0.4km stretch of the river) to the location of the proposed option. The option results in a decrease in water levels, the maximum of 0.7m occurring on the Broadmeadow River (cross section 4Ba19221U - directly upstream of the R125 crossing) and 0.9m on the Broadmeadow tributary (cross section 4Bax322In).

Potential impact on principal overland flow routes and areas of significant natural floodplain storage

The results of the modelling indicate that existing overland flood flow paths are modified with this option. These existing overland flow paths (northwards across the R125 and southwards from the tributary) are as a result of capacity problems at existing structures and lead to the flooding of properties at Ratoath. The option prevents these overland flow paths through increasing the capacity of the structures. Modelling indicates that the alteration of the flow paths does not increase risk to properties elsewhere.

The capacity of the existing culvert on the Broadmeadow tributary results in surcharging of the culvert and attenuation of floodwater on surrounding farm land. The increased culvert capacity as part of this option will prevent flooding of surrounding land and reduce the need for floodplain attenuation.

Multi Criteria Analysis (MCA) Results

Benefit Cost Ratio (BCR)		MCA scores				
Benefits of option	€978,175	Technical	Economic	Social	Environmental	**Overall**
Cost of option	€1,090k	225	135	90	-65	**385**
BCR	0.91 (0.94 with 0.1% AEP)	Replacement culverts design to pass the 95%ile 1% MRFS without surcharging. This flow is less than the 0.1% AEP current scenario flow and therefore reduction in the 0.1% AEP damage is also achieved, thus increasing the BCR.				

SEA Conclusions and recommendations

- Significant positive effects as a result of the reduction in flood risk to nine residential properties, transport infrastructure (i.e. 90m of regional road) and 2ha of agricultural land; and
- Minor negative effects on flora and fauna, fisheries and landscape character and visual amenity within the river channels.

Details of the assessment are provided in the SEA ER.

Rowlestown East area APSR

Assessment units	Rowlestown East area APSR
Water bodies	Broadmeadow
Preferred flood risk management option	Construction of flood defence embankments along left bank of Broadmeadow River tributary upstream of the R125.

Flood Risk (1% AEP event)

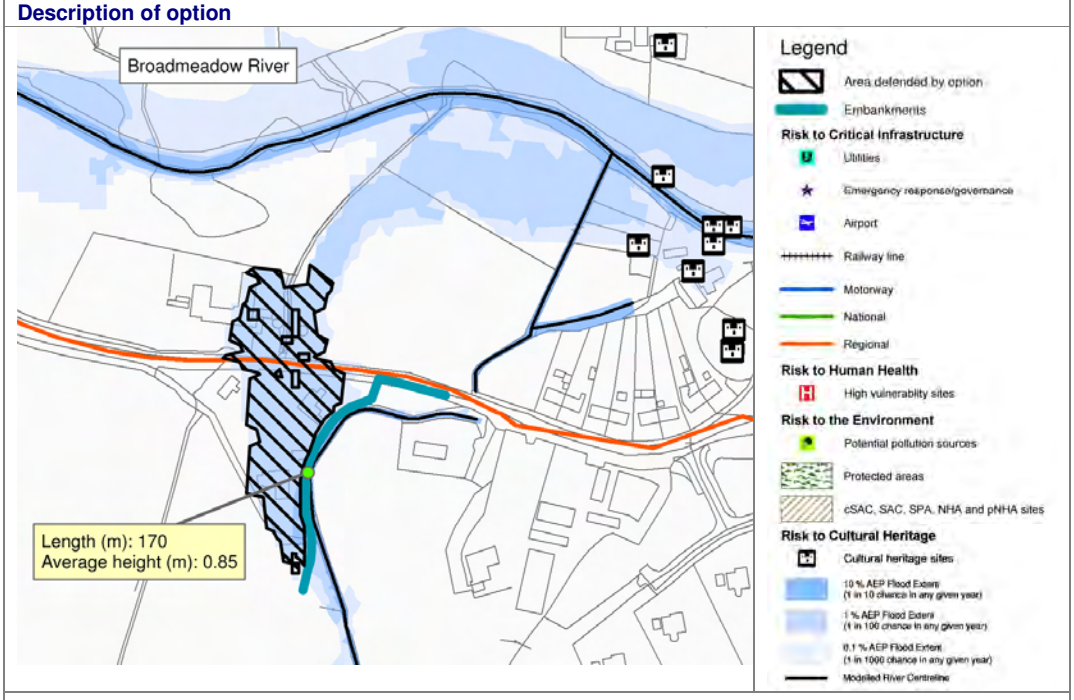
Flood risk in Rowlestown East area APSR is caused by out of bank flooding along the Broadmeadow River primarily due to an under capacity channel upstream of the R125. Two properties are at risk of flooding in this location.

Properties		Utility assets (No.)	Transport routes (length km)	Agricultural land (hectares)	Social amenity sites (No.)
Residential (No.)	Non-residential (No.)				
2	0	0	0.08	5.4	0

Environmental features and receptors present or at risk

- 3 river water bodies: 3 = poor status
- 2 Waste Management Permit Sites
- 3 sites on the SMR/RPS/RMP

Description of option



This option involves the construction of a flood defence embankment along the left bank of the Broadmeadow tributary in Rowlestown. Out of bank flows along the left bank results in flooding of two properties. A total of 170m of embankment is required with an average height of 0.85m above ground level including 0.5m freeboard. The figure above shows the location of the proposed embankments. Further details are available in Appendix E1.

Modelling results indicate that this option will have negligible impact on water levels upstream and downstream of the location of the proposed option. Changes in water levels are localised to the vicinity of the proposed option (within 120m upstream and 240m downstream of the embankment). The option results in an increase in water levels with a maximum increase of 0.32m (cross section 4Bap205U).

Potential impact on principal overland flow routes and areas of significant natural floodplain storage

The construction of the embankment eliminates the existing overland flood flow path resulting in a localised

increase in water levels in the river channel. Modelling indicates that this localised increase in water levels does not increase flood risk to properties elsewhere. There are no areas of significant natural floodplain storage affected by this option.

Multi Criteria Analysis (MCA) Results

Benefit Cost Ratio (BCR)		MCA scores				
Benefits of option	€341,628	Technical	Economic	Social	Environmental	**Overall**
Cost of option	€153,301	100	130	90	-95	**225**
BCR	2.23					

SEA Conclusions and recommendations

- Significant positive effects as a result of the reduction in flood risk to two residential properties and transport infrastructure (i.e. 80m of regional road);
- Minor positive effects as a result of the reduction in flood risk to 2.4ha of agricultural land and three cultural heritage sites; and
- Significant negative effects on landscape character and visual amenity; and
- Minor negative effects on flora and fauna, fisheries and landscape character and visual amenity; and a potential constraint to the achievement of good ecological status to meet WFD objectives.

Details of the assessment are provided in the SEA ER.

Mayne & Sluice AU

Assessment units	Mayne and Sluice AU
Water bodies	Mayne, Sluice
Preferred flood risk management option	Flood forecasting and warning system for the Mayne River

Flood Risk (1% AEP event)

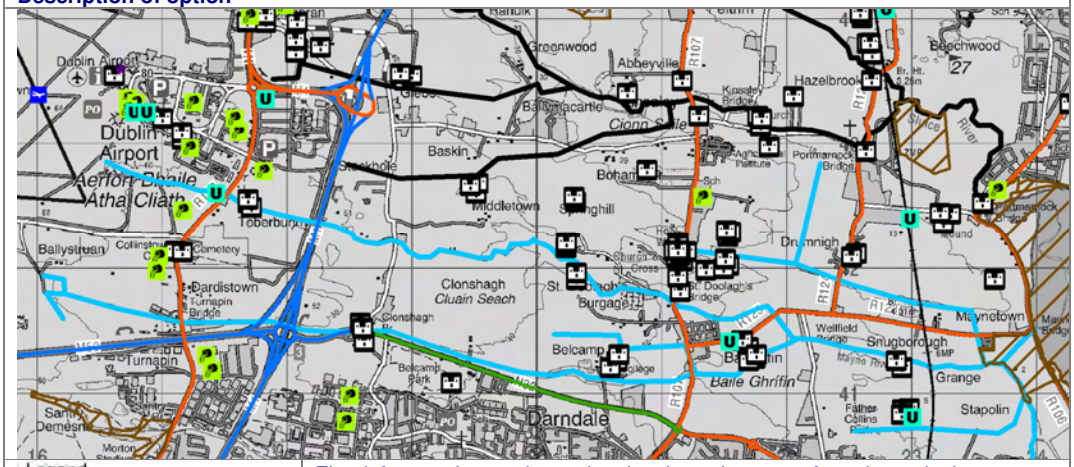
There is limited economic flood risk to properties in the AU for the 1% AEP event with the majority of the risk confined to small clusters of properties at Balgriffin and Streamstown. Elsewhere in the AU, the risk is limited to isolated properties along the rivers. There is one IRR in the AU; approximately 100m of the N32 near Bewleys Airport Hotel in Clonshaugh.

Properties		Utility assets (No.)	Transport routes (length km)	Agricultural land (hectares)	Social amenity sites (No.)
Residential (No.)	Non-residential (No.)				
28	3	0	0.7	31	2

Environmental features and receptors present or at risk

- 2 river water bodies: 1 = high status; 1 = poor status
- 6 Waste Management Permit Sites
- 4 Section 4 licences and 18 Section 16 licences
- Feltrim Hill pNHA
- 6 sites on the SMR/RPS/RMP

Description of option



Legend

- FFWS along Mayne River
- Modelled river centreline

Risk to Critical Infrastructure

- Utilities
- Emergency response/governance
- Airport
- Railway line
- Motorway
- National
- Regional

Risk to Human Health

- High vulnerability sites

Risk to the Environment

- Potential pollution sources
- Protected areas
- cSAC, SAC, SPA, NHA and pNHA sites

Risk to Cultural Heritage

- Cultural heritage sites

Flood forecasting and warning involves the use of mathematical computer models to predict flood water levels, based on actual meteorological conditions, and tools to disseminate flood hazard data to people at risk. Further information on the viability of various flood forecasting options are reported on in the Preliminary Options Report. Flood forecasts would be disseminated through a dedicated website and messaging service to provide advance warning to communities.

A FFWS for the Mayne River would provide advance flood warning to properties at risk along the Mayne River in St Margaret's, Dublin Airport, Belcamp and Balgriffin areas APSR. The image above shows the Mayne River and flood risk indicators within the catchment of the Mayne River. Those indicators in the floodplain of the Mayne River are likely to benefit from the proposed FFWS. Further details are available in Appendix E3.

Potential impact on principal overland flow routes and areas of significant natural floodplain storage						
This option has no impact on overland flow paths or significant natural flood plain storage.						
Multi Criteria Analysis (MCA) Results						
Benefit Cost Ratio (BCR)		MCA scores				
Benefits of option	€185,305	Technical	Economic	Social	Environmental	**Overall**
Cost of option	€450,803	200	25	0	0	**225**
BCR	0.41 (1.64 with IPFP)	More benefit can be achieved from FFWS if it is implemented in conjunction with IPFP (study area option 2).				
SEA Conclusions and recommendations The effects of this option on the SEA receptors in the Mayne River catchment would be neutral (where applicable), with no significant (i.e. moderate or major), minor positive or negative changes relative to the existing conditions **Details of the assessment are provided in the SEA ER.**						

St Margaret's, Dublin Airport, Belcamp and Balgriffin areas APSR

Assessment units	Mayne and Sluice AU
Water bodies	Mayne, Sluice
Preferred flood risk management option	Improve channel conveyance by removing a disused bridge with construction of flood defence embankments & walls.

Flood Risk (1% AEP event)

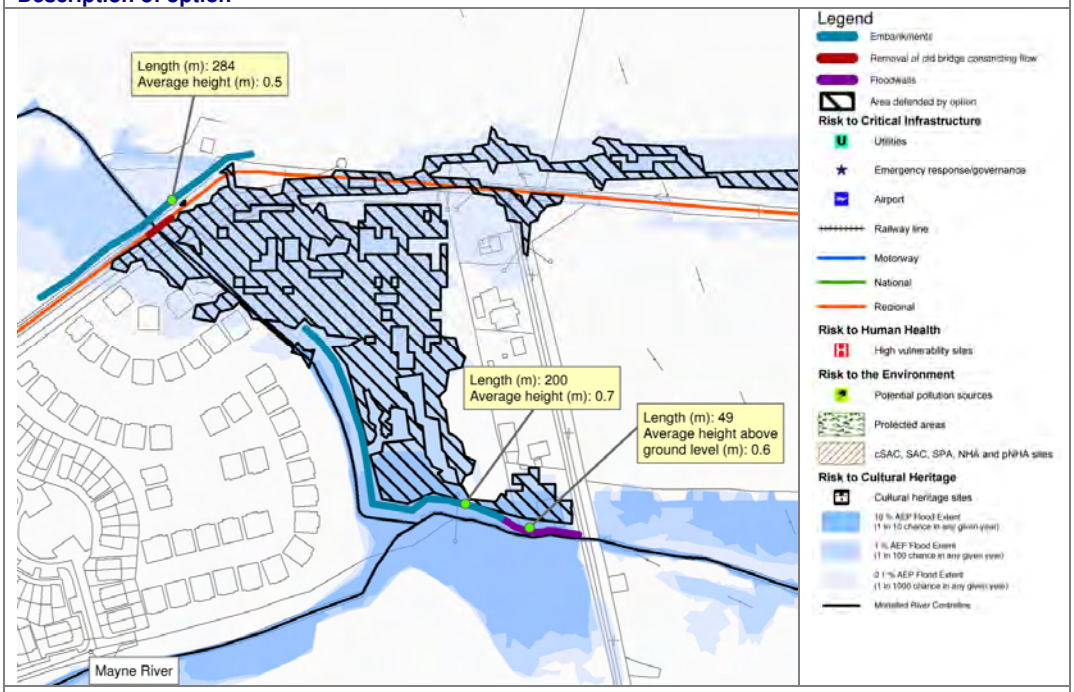
There is limited economic flood risk to properties in the AU for the 1% AEP event with the majority of the risk confined to small clusters of properties at Balgriffin and Streamstown. Elsewhere in the AU, the risk is limited to isolated properties along the rivers. There is one IRR at risk; approximately 100m of the N32 near Bewleys Airport Hotel in Clonshaugh.

Properties		Utility assets (No.)	Transport routes (length km)	Agricultural land (hectares)	Social amenity sites (No.)
Residential (No.)	Non-residential (No.)				
19	2	0	0.7	5	1

Environmental features and receptors present or at risk

- 3 river water bodies: 1 = high status; 2 = poor status
- 6 Section 4 licences and 17 Section 16 licences
- 4 sites on the SMR/RPS/RMP

Description of option



This option involves the construction of a flood defence embankment north of the R123 on the Mayne River tributary and the construction of embankments and walls along the left bank of the Mayne River and tributary at Balgriffin. The option also involves removing an unused bridge structure north of the R123. Hydraulic modelling indicates that this unused bridge increases water levels locally. By removing this bridge structure, the extent and height of embankments to the north of the R123 will be reduced. Hydraulic modelling also indicates that replacing existing culverts at the R123 and housing development at Balgriffin is not necessary as part of this option as they are sufficient to accommodate the 1% AEP event without surcharging.

A 280m embankment with an average height of 0.5m running east west along the R123 is required to prevent flood water spilling south across the R123. Further downstream, a 200m long embankment with an average height of 0.7m is required on the left bank of the Mayne River and its tributary to prevent out of bank flooding downstream. This embankment is linked to a flood wall on the Mayne River, 50m in length, with an average

height of 2.4m (due to space constraints, wall constructed to the bed of the channel). The average height of this wall above ground level is approximately 0.6m.

Modelling results indicate that this option will have some localised impact on water levels upstream and downstream of the proposed location for this option. Upstream of the R123, water levels on the Mayne River tributary are lowered by an average of 0.12m along a 120m stretch of the channel. Downstream of the R123, water levels on the Mayne River and its tributary are raised by an average of 0.16m along 430m of river channel. Downstream of the bridge at The Hollow, there are no changes in water levels.

Potential impact on principal overland flow routes and areas of significant natural floodplain storage

The results of the modelling indicate that existing overland flood flow paths are modified with this option. These existing overland flow paths from the Mayne River tributary (southwards across the R123) are as a result of capacity problems at an existing old stone bridge structure and lead to the flooding of properties at Balgriffin. The option prevents these overland flow paths by removing the bridge structure and constructing embankments and walls to protect the properties. There are no areas of significant natural floodplain storage affected by this option but some reduction in floodplain storage does occur.

Multi Criteria Analysis (MCA) Results

Benefit Cost Ratio (BCR)		MCA scores				
Benefits of option	€955,548	Technical	Economic	Social	Environmental	**Overall**
Cost of option	€752,281	100	130	210	-100	**340**
BCR	1.27					

SEA Conclusions and recommendations

- Significant positive effects as a result of the reduction in flood risk to 19 residential and two non-residential properties (i.e. positive community effects) and transport infrastructure (i.e. up to 600m of regional road);
- Minor negative effects due to an increase in flood risk to 5ha of agricultural land; impacts on local flora and fauna, fisheries and landscape character and visual amenity; and a potential constraint to the achievement of good ecological status to meet WFD objectives.

Details of the assessment are provided in the SEA ER.

Coastal AU

Assessment units	Coastal AU
Water bodies	Fingal and Meath coastline, Mayne River, Sluice River, Gaybrook Stream, Broadmeadow River, Ward River, Lissenhall Stream, Turvey River, Ballyboghil River, Corduff River, Baleally Stream, Bride's Stream, Jones's Stream, Rush Town Stream, St. Catherine's Stream, Mill Stream, Bracken River, Delvin River, Mosney Stream, Nanny River and Brookside stream
Flood risk management options	Develop a combined fluvial and tidal FFWS.

Flood Risk (1% AEP event)

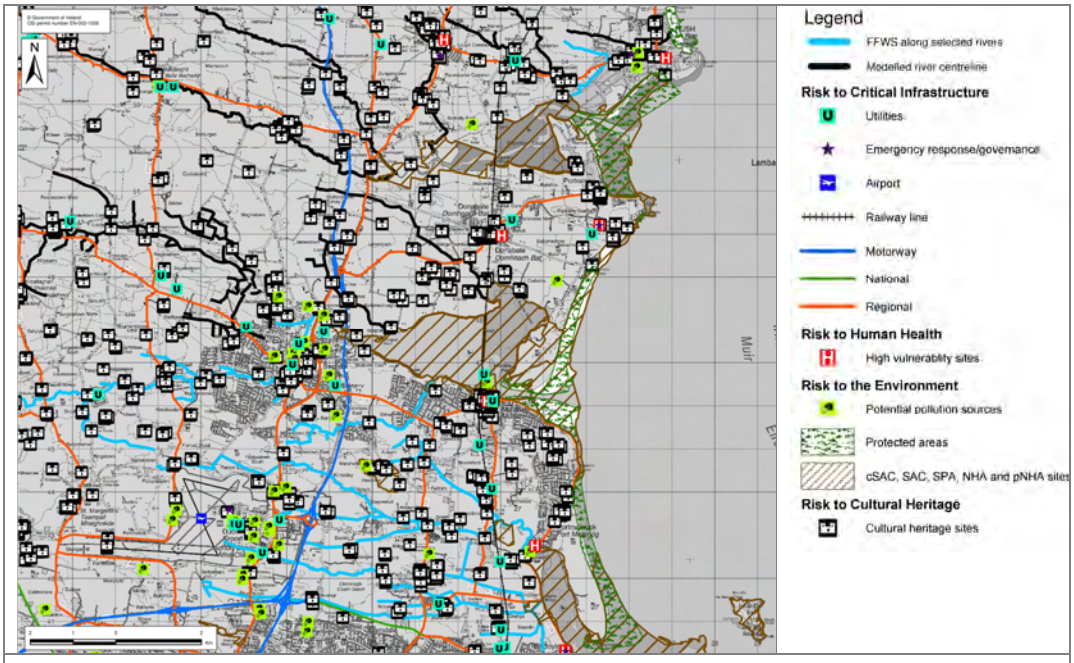
The Coastal AU is at risk from a number of sources of flooding: tidal flooding only, fluvial flooding only and a combination of tidal and fluvial flooding. There are a number of areas along the Fingal and Meath coast at economic risk for the 1% AEP fluvial event and 0.5% AEP tidal event. The majority of the risk is confined to urban areas along the coast and in particular along the estuaries of the rivers discharging to the Irish Sea. There are a number of locations where the economic risk is directly from coastal flooding from the Irish Sea (e.g. Harbour Road in Skerries area APSR) or from fluvial flooding from the rivers (e.g. Mill Stream in Skerries area APSR). There is one IRR at risk, a WWTW in Julianstown area APSR.

Properties		Utility assets (No.)	Transport routes (length km)	Agricultural land (hectares)	Social amenity sites (No.)
Residential (No.)	Non-residential (No.)				
182	54	1	2.5	350	7

Environmental features and receptors present or at risk

- 8 river water bodies: 1 = high status; 2 = good status; 1 = moderate status; 3 = poor status; 1 = bad status
- 4 transitional (i.e. estuarine) water bodies: 4 = moderate status
- 4 coastal water bodies: 2 = high status; 2 = moderate status
- 1 wastewater treatment works
- 13 Waste management permit sites
- 4 Section 4 licences and 15 Section 16 licences
- Boyne Coast and Estuary SAC/pNHA; Boyne Estuary SPA; River Nanny Estuary and Shore SPA; Laytown Dunes and Nanny Estuary; Loughskinny Coast pNHA; Rogerstown Estuary SAC/SPA/Ramsar site/pNHA; Malahide Estuary SAC/pNHA; Broadmeadow-Swords Estuary SPA/Ramsar site; Baldoyle Bay SAC/SPA/Ramsar site/pNHA; Sluice River Marsh pNHA
- 21 sites on Meath County Council's Wetland Inventory, and 92 sites listed on the Coastal Inventory
- 29 sites on the SMR/RPS/RMP

Description of option



Flood forecasting and warning involves the use of mathematical computer models to predict flood water levels, based on actual meteorological conditions, and tools to disseminate flood hazard data to people at risk. Further information on the viability of various flood forecasting options are reported on in the Preliminary Options Report. Flood forecasts would be disseminated through a dedicated website and messaging service to provide advance warning to communities.

Through the Irish Coastal Protection Strategy Study (ICPSS), low-resolution tidal-surge forecasting capability has been developed around the Irish Coast. The system is a purely tidal-surge forecasting model and as part of this option would be developed to generate a combined fluvial and tidal FFWS.

FFWS would be required for the Irish Sea along the Meath and Fingal coastline and for the following rivers: Mill Stream, Rush West Stream, Ward River, Gaybrook Stream and Sluice River (consideration has been given to a fluvial FFWS on the Nanny River, Broadmeadow River and Mayne River as part of the Nanny and Delvin AU and the Mayne and Sluice AU respectively).

The image above shows flood risk indicators along the coast and in catchments where fluvial FFWS are proposed. Those indicators in the coastal and fluvial floodplains where forecasting is proposed are likely to benefit from the proposed FFWS.

Potential impact on principal overland flow routes and areas of significant natural floodplain storage

There is no impact on principal overland flow routes and areas of significant natural floodplain storage.

Multi Criteria Analysis (MCA) Results

Benefit Cost Ratio (BCR)		MCA scores				
Benefits of option	€3,669k	Technical	Economic	Social	Environmental	**Overall**
Cost of option	€1,762k	200	25	0	0	**225**
BCR	2.08 (7.29 with IPFP)	Significantly more benefit can be achieved from FFWS if it is implemented in conjunction with IPFP (study area option 2).				

SEA Conclusions and recommendations

The effects of this option on the SEA receptors in the coastal area would be neutral (where applicable), with no significant (i.e. moderate or major), minor positive or negative changes relative to the existing conditions

Details of the assessment are provided in the SEA ER.

Portmarnock and Malahide areas APSR options

Assessment units	Portmarnock and Malahide areas APSR
Water bodies	Fingal and Meath coastline, Gaybrook Stream, Broadmeadow Estuary, Sluice River
Preferred flood risk management option (Strand Road, Portmarnock)	Rehabilitating and raising existing coastal defences at Strand Road (including rehabilitation walls and flapped outfall) and construction of flood defence embankment.

Flood Risk (1% AEP event)

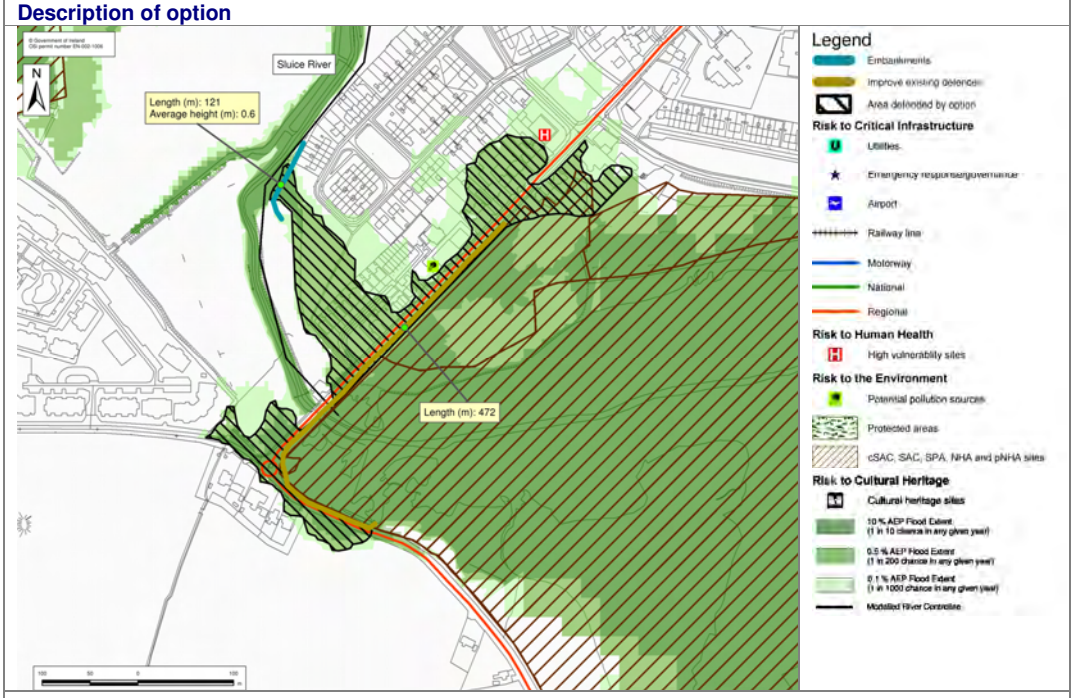
At Strand Road in Portmarnock, 18 properties are at risk from a combination of fluvial (Sluice River) and tidal flooding. In Malahide, the flood risk is from tidal flooding only from the Broadmeadow estuary resulting in 37 properties in Malahide town centre being at risk of flooding. A small number of properties in other locations within the APSR are also at risk of flooding.

Properties		Utility assets (No.)	Transport routes (length km)	Agricultural land (hectares)	Social amenity sites (No.)
Residential (No.)	Non-residential (No.)				
46	16	0	1.0	38	0

Environmental features and receptors present or at risk

- 2 river water bodies: 1 = high status; 1 = poor status
- 2 transitional (i.e. estuarine) water bodies: 2 = moderate status
- 2 coastal water bodies: 2 = moderate status
- 3 Section 16 licences
- Malahide Estuary SAC/pNHA; Broadmeadow-Swords Estuary SPA/Ramsar site; Baldoyle Bay SAC/SPA/Ramsar site/pNHA; Sluice River Marsh pNHA
- 1 site on the SMR/RPS/RMP

Description of option



This option involves rehabilitating (i.e. strengthening and raising) 0.5km of existing walls which run alongside the R106 at Strand Road. The option also involves rehabilitating of the flapped gates on the Sluice River at Portmarnock Bridge and the construction of a flood embankment on the left bank of the Sluice River upstream of Portmarnock Bridge.

The existing flood walls and their foundations would be strengthened using structural engineering works to allow walls to provide sufficient flood defence function up to the 0.5% AEP tidal event. The flapped gates on

the Sluice River at Portmarnock Bridge prevent the propagation of high tides upstream of this bridge. These gates would be replaced with new flapped gates as part of this option. 120m of flood embankments are required upstream of Portmarnock Bridge. The average height of these embankments is 0.6m and provides protection up to the 1% AEP fluvial event and 0.5% AEP tidal event. Hydraulic modelling indicates that there is no impact on water levels upstream or downstream of Strand Road.

Potential impact on principal overland flow routes and areas of significant natural floodplain storage

The construction of the flood embankment along the left bank of the Sluice River prevents an existing overland flow path (westwards through Hazel Grove and across the R106), however, this would not be considered a principal overland flow route. There are no areas of significant natural floodplain storage affected by this option.

Multi Criteria Analysis (MCA) Results

Benefit Cost Ratio (BCR)		MCA scores				
Benefits of option	€1,554k	Technical	Economic	Social	Environmental	**Overall**
Cost of option	€1,555k	25	120	210	-260	**95**
BCR	1.0					

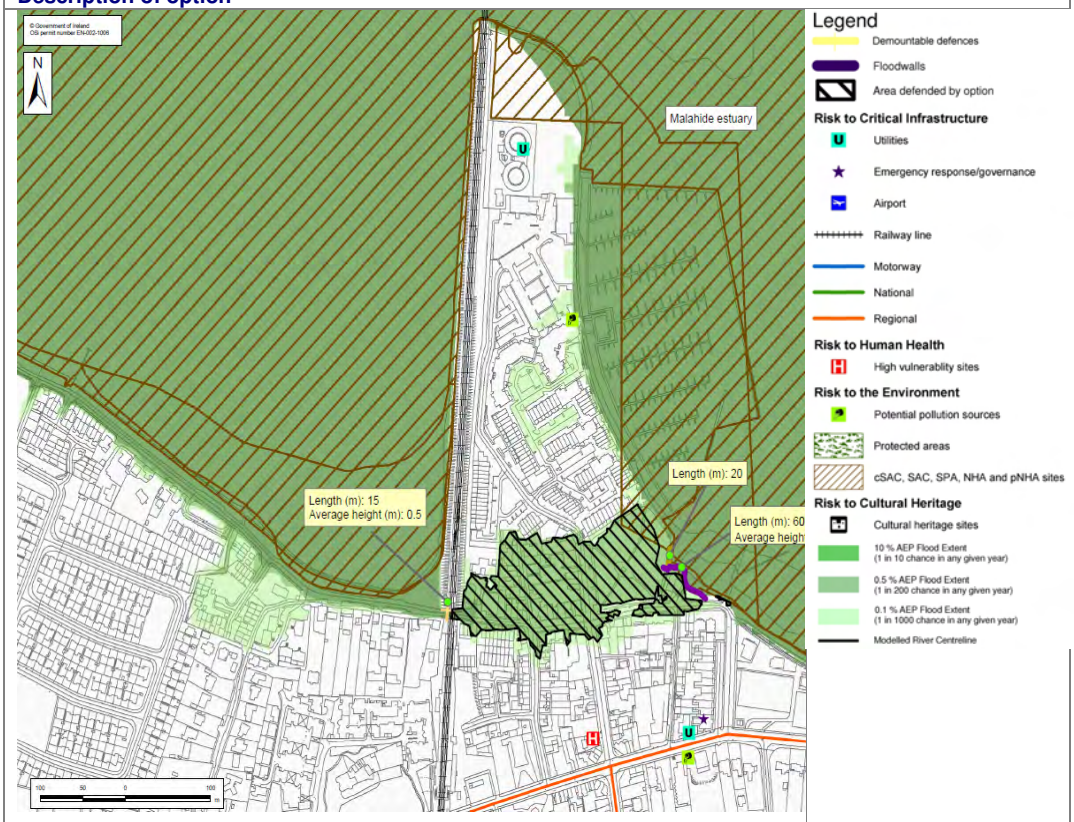
SEA Conclusions and recommendations

- Significant positive effects as a result of the reduction in flood risk to 17 residential properties and one non-residential property (i.e. positive community effects) and transport infrastructure (i.e. up to 650m of regional road)
- Significant negative effects on flora and fauna (in particular Baldoyle Bay cSAC/SPA/pNHA and Sluice River pNHA); and landscape character and visual amenity (within a designated Important View)
- Minor negative effects on fisheries and a potential constraint to the achievement of good ecological status to meet WFD objectives

Details of the assessment are provided in the SEA ER.

Assessment units	Portmarnock and Malahide areas APSR
Water bodies	Fingal and Meath coastline, Gaybrook Stream, Broadmeadow Estuary, Sluice River
Preferred flood risk management option (Malahide town centre)	Construction of demountable flood defences at underpass, along with flood walls/demountable walls and localised raising of existing defences

Description of option



This option involves the construction of 60m of flood walls and the raising of a short section of flood wall (approximately 20m) in Malahide town centre. The option also involves the construction of a demountable flood defence across the railway underpass to prevent the propagation of flood waters along the coast road eastwards into Malahide town centre. The option provides protection to properties in Malahide town centre against tidal flooding up to the 0.5% AEP tidal event. It does not reduce the flood risk to properties along the coast road. The 0.5% AEP tidal flood maps indicate that the flood risk along the coast road affects the gardens and driveways of properties and does not result in economic damages to any buildings. It is noted that the Local Authority and the OPW will need to agree who is responsible for the installation of these demountable defences. It is also noted that the permission of Irish Rail may also be required.

A demountable defence across the railway underpass on the coast road would cut off the flow path of flood water under the railway underpass and into Malahide town centre. This option would limit the movement of people and traffic prior to and during a flood event and the traffic management plan would need to consider this issue. Additional investigations would be required to determine if the railway embankment would prevent the ingress of water eastwards into Malahide town centre. This option does not prevent flooding of properties along the coast road.

Potential impact on principal overland flow routes and areas of significant natural floodplain storage

The construction of the flood embankment and revetments along the coast road prevents flooding along the coast road, under the railway underpass and into Malahide town centre. There are no areas of significant natural floodplain storage affected by this option.

Multi Criteria Analysis (MCA) Results						
Benefit Cost Ratio (BCR)		MCA scores				
Benefits of option	€2,730k	Technical	Economic	Social	Environmental	**Overall**
Cost of option	€2,203k	0	180	240	-70	**350**
BCR	1.2 (6.2 with FFWS)	This option requires a FFWS to be implemented. The higher cost/lower BCR includes a specific FFWS with this option. If it is assumed that Coastal AU option 1 is implemented the specific cost for a FFWS for this option can be removed thus increasing the BCR.				

SEA Conclusions and recommendations

- Significant positive effects as a result of the reduction in flood risk to up to 22 residential and 15 non-residential properties (i.e. positive community effects) and transport infrastructure (i.e. up to 350m of regional road)
- Minor negative effects on flora and fauna (including designated sites: Broadmeadow-Swords Estuary SPA/Ramsar site); and landscape character and visual amenity

Details of the assessment are provided in the SEA ER.

Swords area APSR option

Assessment units	Swords area APSR
Water bodies	Gaybrook Stream, Broadmeadow River, Ward River, Lissenhall Stream
Preferred flood risk management option	Widening the Gaybrook Stream to reduce fluvial flood risk to properties at Aspen near Kinsaley.

Flood Risk (1% AEP event)

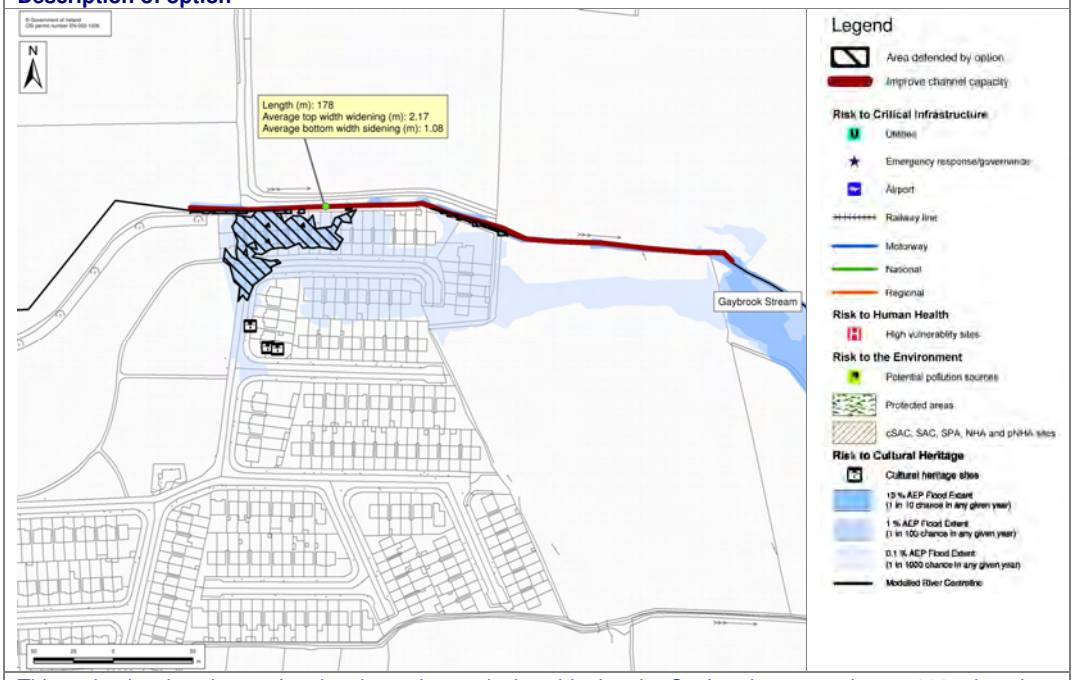
In Swords area APSR, 9 residential properties are at risk of flooding in the Aspen estate from the Gaybrook Stream and 7 non-residential properties (including a fire station) are at risk Swords town centre from the Ward River. The remaining at risk properties are in isolated locations around Swords, including 4 non-residential properties in the Airside Retail Park, which are at risk from the Gaybrook Stream but incur very low economic damages.

Properties		Utility assets (No.)	Transport routes (length km)	Agricultural land (hectares)	Social amenity sites (No.)
Residential (No.)	Non-residential (No.)				
13	15	0	0.12	12	0

Environmental features and receptors present or at risk

- 4 river water bodies: 1 = high status; 2 = moderate status; 1 = poor status
- 1 transitional (i.e. estuarine) water bodies: 1 = moderate status
- 2 Section 4 licences and 7 Section 16 licences
- Malahide Estuary SAC/pNHA; Broadmeadow-Swords Estuary SPA/Ramsar site
- 3 sites on the SMR/RPS/RMP

Description of option



This option involves increasing the channel capacity by widening the Gaybrook stream along a 200m length at Aspen. Hydraulic modelling indicates that the top width of the channel would need to be widened by an average of 2m while the bottom width of the channel would need to be widened by an average of 1m between surveyed cross sections 3Ga2306 and 3Ga2128. These channel modifications contain the 1% AEP fluvial event in bank with a 0.3m freeboard (i.e. 1% AEP water levels are 0.3m below top of bank).

The results of the hydraulic modelling show that this option modifies water levels locally with an average decrease in water levels of 0.3m along the 200m length of widened channel. Downstream of the channel

widening, there is a negligible increase in water levels.

Potential impact on principal overland flow routes and areas of significant natural floodplain storage

No principal overland flow routes are modified with this option and there are no areas of significant natural floodplain storage affected by this option.

Multi Criteria Analysis (MCA) Results

Benefit Cost Ratio (BCR)		MCA scores				
Benefits of option	€193,440	Technical	Economic	Social	Environmental	**Overall**
Cost of option	€54,166	125	90	90	-110	**195**
BCR	3.6					

SEA Conclusions and recommendations

- Significant positive effects as a result of the reduction in flood risk to 9 residential properties and transport infrastructure (i.e. short stretch of local roads)
- Minor negative effects on flora and fauna, fisheries and landscape character and visual amenity; and a potential constraint to the achievement of good ecological potential to meet WFD objectives

Details of the assessment are provided in the SEA ER.

Rush area APSR option

Assessment units	Rush area APSR
Water bodies	St Catherine's Stream, Rush Town Stream, Rush West Stream, Jone's Stream, Rogerstown Estuary
Preferred flood risk management option	Construction of secondary culvert along Channel Road to protect properties at risk from fluvial flooding along the Rush West stream.

Flood Risk (1% AEP event)

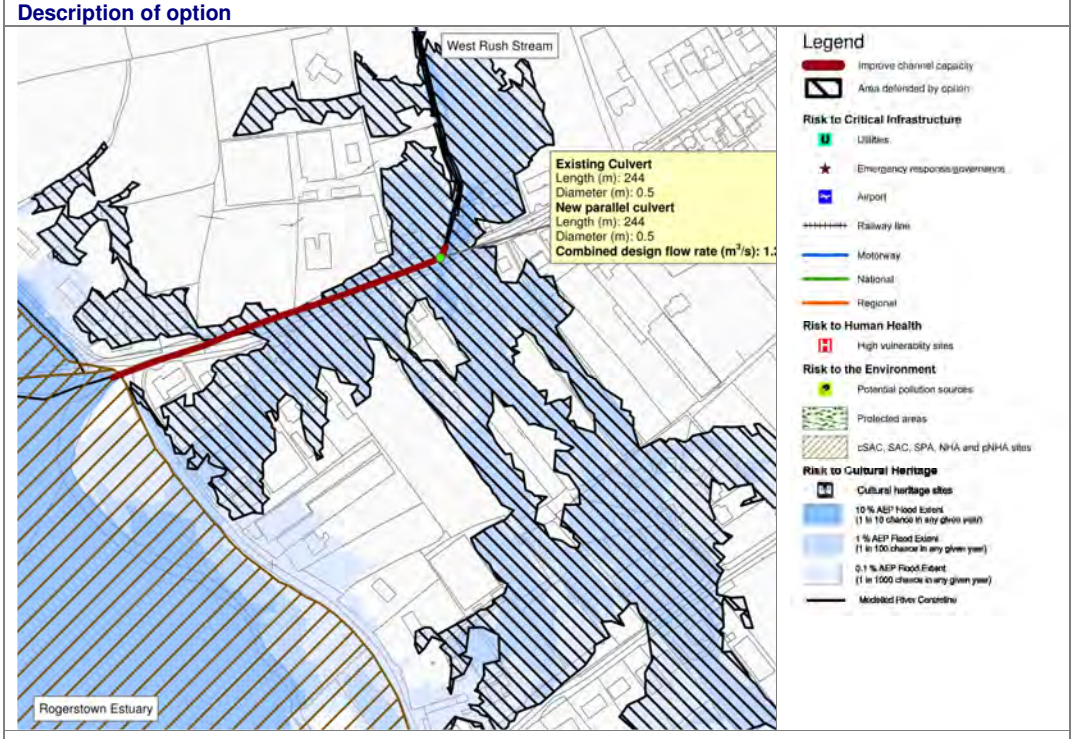
At Rush area APSR, the flood risk is from two separate sources; fluvial flooding from the Rush West Stream and tidal flooding from Rogerstown estuary. The options proposed do not protect 17 properties that area also at risk from tidal flooding. However, the risk from tidal flooding is less than that from fluvial flooding with significantly less economic damages being incurred from tidal flooding only.

Properties		Utility assets (No.)	Transport routes (length km)	Agricultural land (hectares)	Social amenity sites (No.)
Residential (No.)	Non-residential (No.)				
25	2	0	0.6	4	1

Environmental features and receptors present or at risk

- 1 river water body: 1 = poor status
- 1 transitional (i.e. estuarine) water bodies: 1 = moderate status
- 1 coastal water bodies: 1 = moderate status
- 1 Waste management permit site
- 2 Section 16 licences
- Rogerstown Estuary SPA/SAC/pNHA
- 2 sites on the SMR/RPS/RMP

Description of option



This option would involve constructing a secondary culvert along side the existing culvert on the downstream end of the Rush West Stream. The capacity of the existing structure is insufficient to convey large flows and results in surcharging and spilling of flood waters and flooding of properties. As the culvert is sized for the 1% MRFS 95%ile flow it can pass the 0.1% AEP fluvial flow without causing any flood damage to property.

Modelling results indicate that a new circular culvert with a diameter of 0.5m when combined with the capacity of the existing structure would be sufficient to reduce fluvial flood risk in Rush. The combined culverts would convey a flow of 1.2m^3/s, which equates to the 1% AEP MRFS 95%ile flow without surcharging.

Modelling results indicate that this option will have some impact on water levels upstream and no impact downstream of the proposed location for this option. Changes in water levels are localised along a 0.3km stretch of the river upstream of the culvert inlet. The option results in an average decrease of 0.36m in water levels upstream of the culvert inlet. The maximum decrease in water levels is 1.0m at the culvert inlet.

Potential impact on principal overland flow routes and areas of significant natural floodplain storage

The results of the modelling indicate that existing overland flood flow paths are modified with this option. These existing overland flow paths are as a result of capacity problems at the entrance to the existing culvert and lead to the flooding of properties in Rush. The option prevents these overland flow paths through increasing the capacity of the culvert. There are no areas of significant natural floodplain storage affected by this option.

Multi Criteria Analysis (MCA) Results

Benefit Cost Ratio (BCR)		MCA scores				
Benefits of option	€432,280	Technical	Economic	Social	Environmental	**Overall**
Cost of option	€584,046	225	35	180	-10	**430**
BCR	0.74 (0.9 for 0.1% AEP)	Replacement culverts designed to pass the 95%ile 1% MRFS without surcharging. This flow is less than the 0.1% AEP current scenario flow and therefore reduction in the 0.1% AEP damage is also achieved, thus increasing the BCR.				

SEA Conclusions and recommendations

- Significant positive effects as a result of the reduction in flood risk to 25 residential properties and transport infrastructure (i.e. up to 600m of local roads)
- Significant negative effects on flora and fauna (in particular Rogerstown Estuary cSAC/SPA/pNHA)
- Minor negative effects on fisheries

Details of the assessment are provided in the SEA ER.

Skerries area APSR option

Assessment units	Skerries area APSR
Water bodies	Fingal coastline, Mill Stream
Preferred flood risk management option	Replacing culverts under roads and railway with larger capacity culverts and widening channel through park to reduce fluvial flood risk to properties at Millar Lane and Sherlock Park.

Flood Risk (1% AEP event)

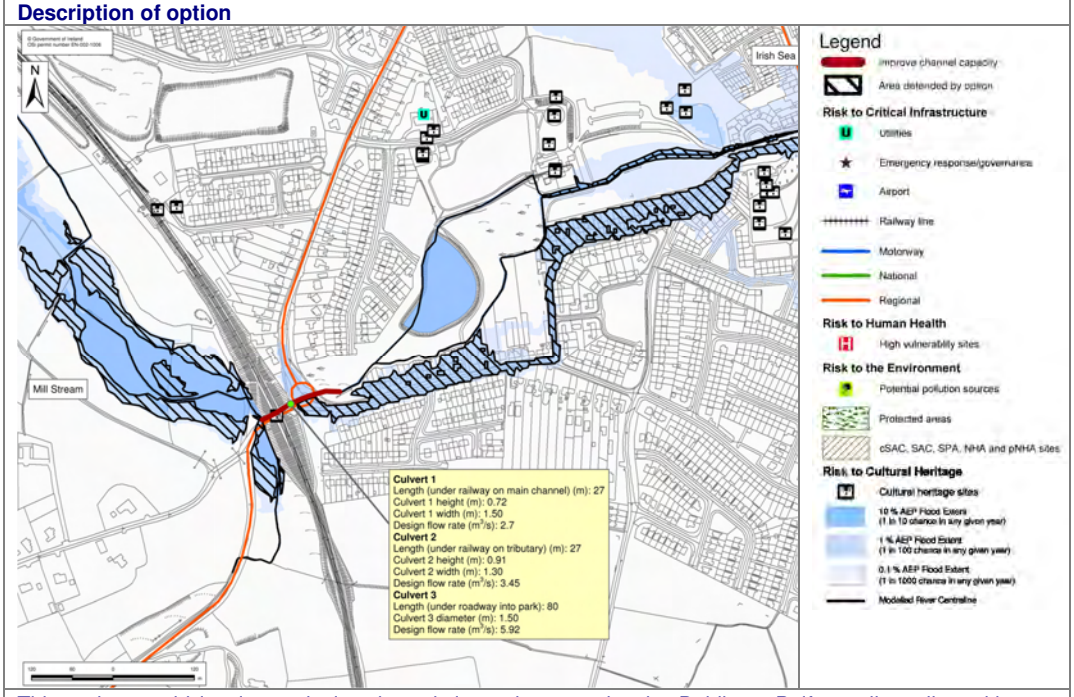
For Skerries area APSR, two separate locations are at risk from different sources of flooding. Along Harbour Road, 12 properties are at risk from tidal flooding. A total of 49 residential properties along Millar Lane and Sherlock Park are at risk of fluvial flooding from the Mill Stream.

Properties		Utility assets (No.)	Transport routes (length km)	Agricultural land (hectares)	Social amenity sites (No.)
Residential (No.)	Non-residential (No.)				
59	2	0	1.7	4	0

Environmental features and receptors present or at risk

- 1 river water body: 1 = good status
- 1 coastal water bodies: 1 = moderate status
- 1 site on the SMR/RPS/RMP

Description of option



This option would involve replacing the existing culverts under the Dublin to Belfast railway line with new larger capacity culverts (which will require consents from Irish Rail). The capacity of the existing culverts is insufficient to convey large flows and results in flood waters ponding on land to the west of the railway embankment and surcharging of existing culverts. This surcharging results in spilling of flood waters along the R127 and floods properties at Millar Lane and Sherlock Park. Hydraulic modelling indicates that it is not necessary to widen and deepen the river channels in the park to accommodate the increased conveyance through the new larger capacity culvert.

The existing culverts under the railway would be replaced with three larger capacity culverts. Hydraulic modelling indicates that the following culverts would be required to convey the 1% AEP MRFS 95%ile flow without surcharging:
- Culvert under the railway on main channel - Box section culvert: Length 27m. Width 1.5m. Height 0.72m
- Culvert under the railway on 15Maa tributary - Box section culvert: Length 27m. Width 1.3m. Height 0.91m

- Culvert under the roadway into the park - Circular culvert: Length 80m. Diameter 1.50m.

Modelling results indicate that this option will have an impact on water levels upstream and downstream of the proposed new culverts. Upstream of the culverts (i.e. to the west of the railway embankment), flood risk to agricultural land is reduced with water levels in the Mill Stream lowered by an average of 0.56m along a 650m length of channel. Along the Mill Stream tributary (west of the railway embankment) water levels are reduced by an average of 0.35m along the modelled reach (i.e. 200m). Downstream of the railway, the increased conveyance capacity of the culverts results in an increase in water levels along the Mill Stream. Water levels are raised by an average of 0.21m along 1.1km of river channel. The maximum increase in water levels occurs at cross section 15Ma1123CD where water levels are raised by 0.44m. This increase in water level does not result in out of bank flooding through the park.

Potential impact on principal overland flow routes and areas of significant natural floodplain storage

The results of the modelling indicate that existing overland flood flow paths are modified with this option. These existing overland flow paths are as a result of capacity problems at the entrance to the existing culverts which results in flood water spilling along the R127 and secondary roads at Millar Lane and Sherlock Park. The option prevents these overland flow paths by increasing the capacity of the culverts. This option also reduces floodplain storage on lands to the west of the railway embankment. Replacing the existing culverts increases the capacity in the channel system, draining the land flooded to the west of the railway embankment.

Multi Criteria Analysis (MCA) Results

Benefit Cost Ratio (BCR)		MCA scores				
Benefits of option	€1,876k	Technical	Economic	Social	Environmental	**Overall**
Cost of option	€1,496k	225	135	180	-35	**505**
BCR	1.3					

SEA Conclusions and recommendations

- Significant positive effects as a result of the reduction in flood risk to 49 residential properties; transport infrastructure (i.e. >1.5km of local roads); up to 4ha of agricultural land
- Minor positive effects resulting from reduction in flood risk to one cultural heritage site
- Minor negative effects on fisheries and landscape character and visual amenity within the river channels

Details of the assessment are provided in the SEA ER.

Laytown, Bettystown and coastal areas APSR

Assessment units	Laytown, Bettystown and coastal areas APSR
Water bodies	Meath coastline, Nanny River, Brookside Stream
Preferred flood risk management option	Construction of flood defence embankments to protect properties at risk along the coast and from the Nanny River.

Flood Risk (1% AEP event)

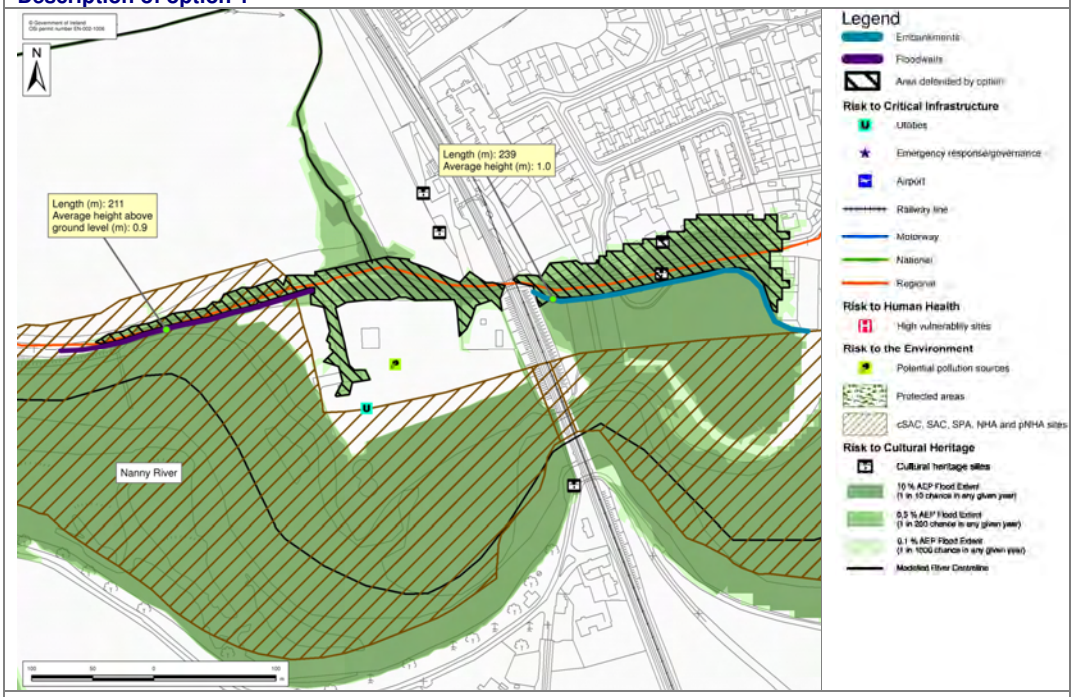
The main flood risk in this APSR is to Laytown from combined fluvial and tidal flood risk along the Nanny River estuary.

Properties		Utility assets (No.)	Transport routes (length km)	Agricultural land (hectares)	Social amenity sites (No.)
Residential (No.)	Non-residential (No.)				
10	1	0	0.5	11	0

Environmental features and receptors present or at risk

- 2 transitional (i.e. estuarine) water bodies: 2 = moderate status
- 2 coastal water bodies: 2 = high status
- Boyne Coast and Estuary SAC/pNHA; Boyne Estuary SPA; River Nanny Estuary and Shore SPA; Laytown Dunes and Nanny Estuary
- 7 sites listed on Meath County Council's Wetland Inventory, and 37 sites listed on the Coastal Inventory
- 2 site on the SMR/RPS/RMP

Description of option 1



This option involves the construction of flood embankments and walls on the left bank of the River Nanny along the R150 southwest of Laytown. Approximately 210m of flood defence walls are required and, where space is available, the flood walls have been set back from the river bank. Along the R150, there is limited space to set the walls back from the river bank and these walls are constructed to the river bed level. The average height of these walls is 1.0m above the top of bank. Immediately downstream of the railway bridge, approximately 240m of flood embankment are required along the left bank of the Nanny River. This embankment is set back from the channel and has an average height of 1.0m. Hydraulic modelling indicates that there is no impact on water levels upstream or downstream of Laytown with this option.

Potential impact on principal overland flow routes and areas of significant natural floodplain storage

The construction of the flood defence wall along the left bank of the River Nanny prevents an existing overland flow route (eastwards along the R150 which continues under the railway bridge and into Laytown). There are no areas of significant natural floodplain storage affected by this option.

Multi Criteria Analysis (MCA) Results – option 1

Benefit Cost Ratio (BCR)		MCA scores				
Benefits of option	€1,705k	Technical	Economic	Social	Environmental	**Overall**
Cost of option	€,1412k	100	120	180	-260	**140**
BCR	1.2					

SEA Conclusions and recommendations

- Significant positive effects as a result of the reduction in flood risk to 10 residential properties and transport infrastructure (i.e. up to 0.45km of regional road)
- Significant negative effects on flora and fauna (in particular the River Nanny Estuary and Shore SPA); and landscape character and visual amenity
- Minor negative effects on fisheries and a potential constraint to the achievement of good ecological status to meet WFD objectives

Details of the assessment are provided in the SEA ER.

Appendix E List of culverts for proactive maintenance by the Local Authorities

Appendix E: List of culverts for proactive maintenance by the Local Authorities

The following is a list of culverts/bridges that were identified during the topographic survey and/or hydraulic modelling as being subject to blockage and, if blocked, could affect nearby property. This list was also reviewed at the workshops and structures were added/deleted based on the knowledge of local area engineers. The culverts/bridges in bold text were used in the risk of blockage of structures and the results were reported on in the hydraulics report.

This is a preliminary list and a review of this list to confirm the risk of blockage should be carried out on a regular basis. In addition, the Local Authority should include any additional culverts/bridges that they encounter that are subject to blocking. It should be noted that the OPW currently maintain the culverts/bridges in Duleek as part of the OPW flood relief scheme.

Table E.1: List of culverts for proactive maintenance by the Local Authorities

River Name	No	Blockage Locations
Broadmeadow (BRO)	5	• **Warblestown Bridge 4Ba5770** • **Ashbourne Bridge @ Bridge Street 4Ba15420** • **Robertstown Br 4Ba12867** • **Moulden Bridge 4Ba19220** • **Tributary in Ashbourne 4Bau2326**
Ward (WAR)	2	• **Balheary Road Bridge 4Wa102 & 4Wa 953** • Swords Town Centre u/s or d/s 4Wa1296
Lissenhall (LIS)	0	None – high ground
Turvey (TUR)	3	• R127 & R126 Turvey Avenue (just d/s M1) 6Ta4353 • M1 crossing 6Ta4822 • d/s 6Ta3920
Rush Road Stream (RUR)	1	• Tomastown Long culvert 14Pa1830
Nanny (NAN)	4	• Kentstown Bridge R153 • Duleek - Kingsgate Br (Parmadden trib) • **Duleek – Main St Br (Parmadden trib)** • R152 at Duleek
Mosney (MOS)	3	• **Mosney St Bridge 19Maa548** • Near Woodland Ave 19Ma742 • 19Ma1191
Delvin (DEL)	3	Three potential locations in Stamullen
Brookside Stream (BSS)	1	• **Laytown Road Bridge**
Corduff (COR)	2	• **N1 Corduff Bridge 8Ca1129** • R127 Dublin Road Bridge 2Ca611

River Name	No	Blockage Locations
Ballyboghill (BAL)	2	• R122 Wyanstown Road Culvert 7Ba10,000 • **Ballyboghill Bridge R108**
Balbriggan Urban (BNS)	0	Mainly culverted
Mill stream (MIL)	1	• **Holmpatrick road bridge 15Ma222**
St. Catherine's Stream (CAT)	1	• CAT – R128 roadbridge
Rush West (RSW)	1	• **RWS – Channel Road culvert (11Wa267)**
Rush Town Stream (RUT)	2	• Skerries Road Br (R128) • Farran's Lane - Screen at 12Ra1448U
Balleally Stream (BAY)	2	Two locations in Lusk 9Ba3905 & **9Ba3030**
Bracken River (BRA)	4	• Rowans Little Area 16Mae33 • **Decoy Bridge 16Ma5361** • **Bridge Street, Balbriggan town ctr 16Ma244U** • R132 16Mab2430
Bride Stream (BRI)	1	• Small access bridge 10La3409 (north Lusk)
Jones Stream (JON)	0	None – mainly rural area
Gaybrook (GAY)	2	• Holywell estate 3Ga3779 • Double box culvert 3GAc899
Mayne (MAY)	3	• N32 culvert 1Ma6020 • **Mayne River at Swords Road (R132) 1Ma7268** • **Cuckoo stream at Wellfield Bridge (R123) 1Mac258**
Sluice (SLU)	6	• Kilsealey Lane Bridge 2Sa3626 • **Portmarnock trotting track 2Sa2300** • Portmarnock trotting track 2Sa2187 • Railway culvert at Hazlebrook 2Saa259 • Back Road short culvert 2Saa2012 & • Back road long culvert 2Saa2373
Nr Locations identified	**49**	

Maps of Bridges that are currently maintained by the OPW

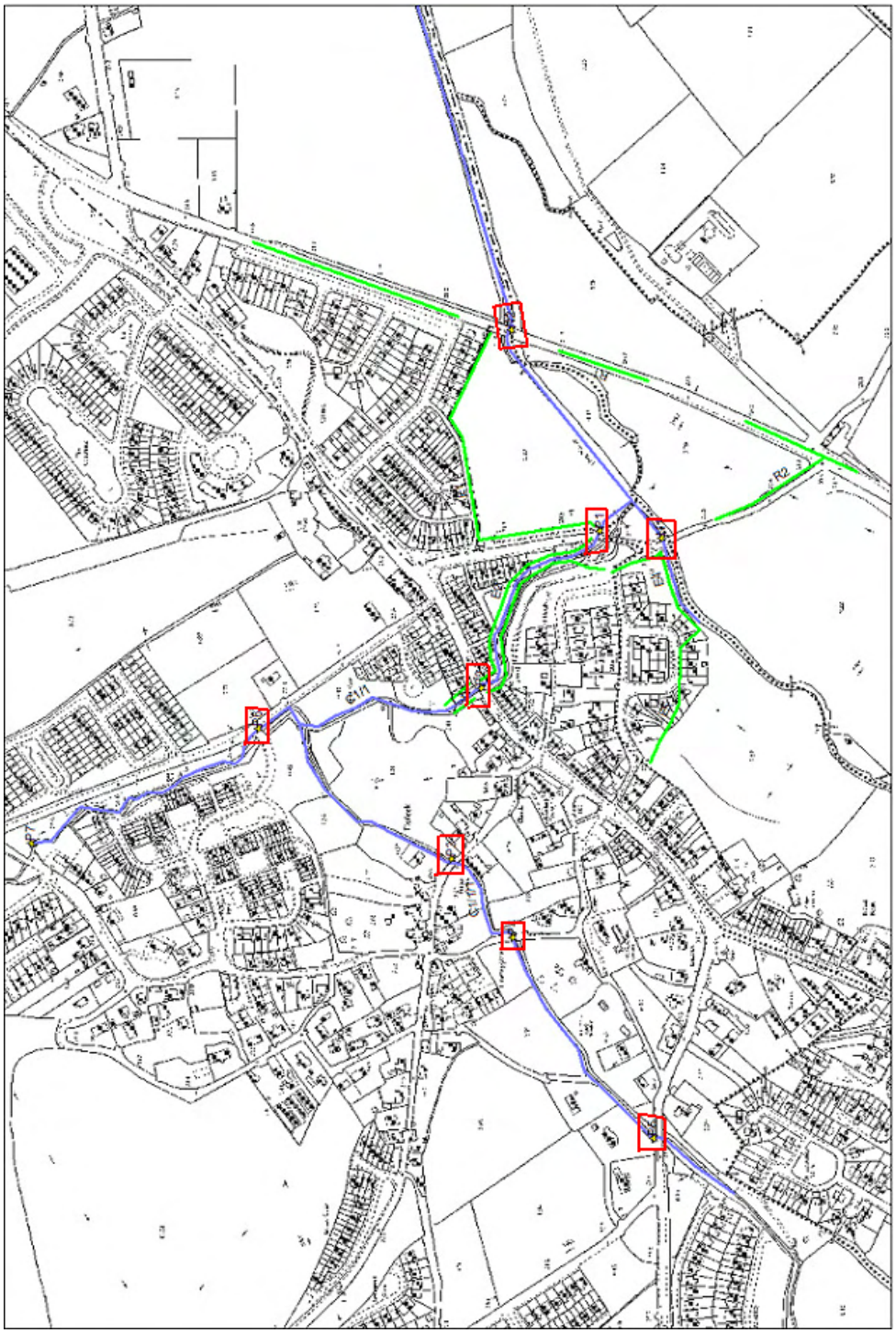


Figure E.1 Duleek Area (source: the OPW)

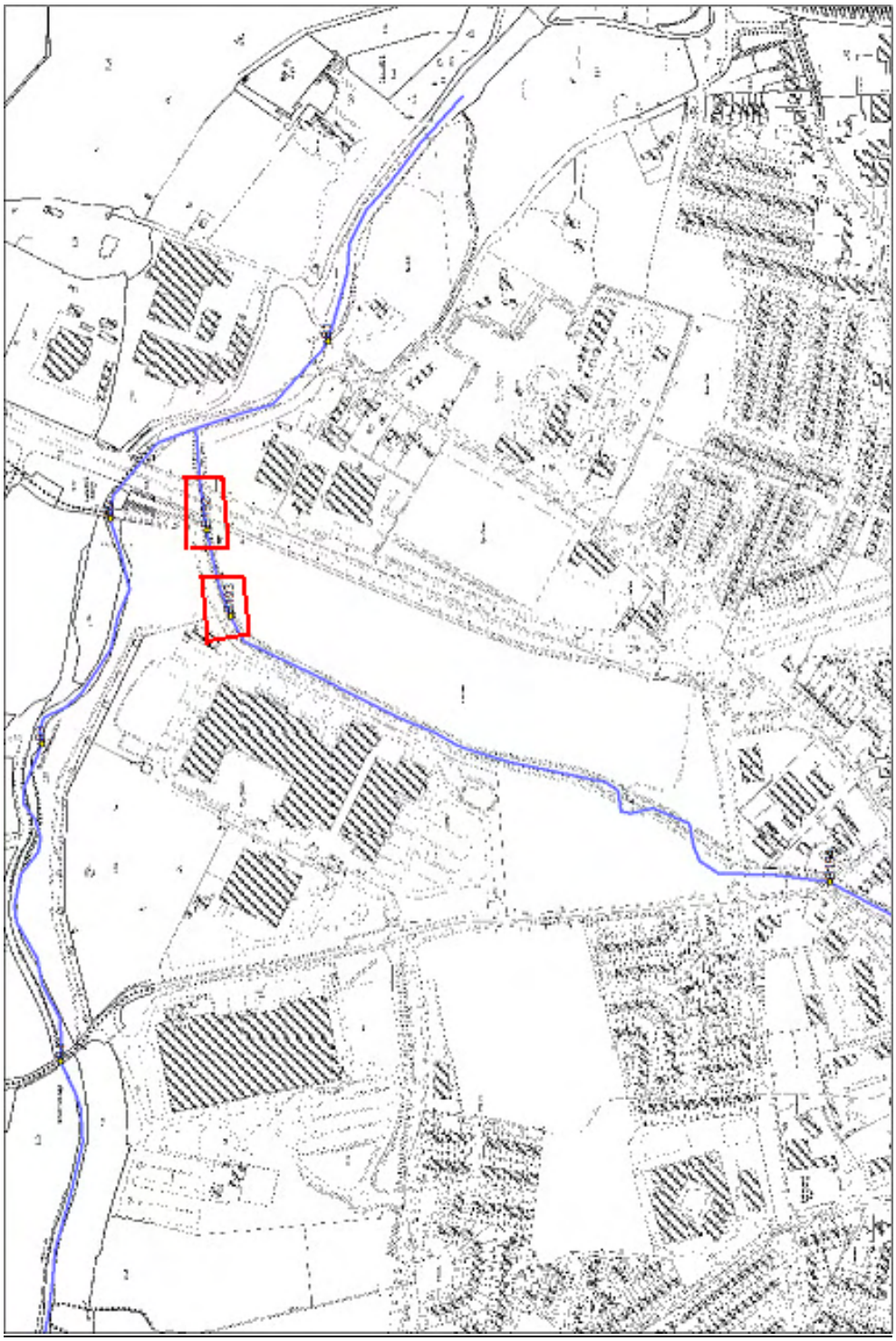


Figure E.2 Swords Area (source: the OPW)

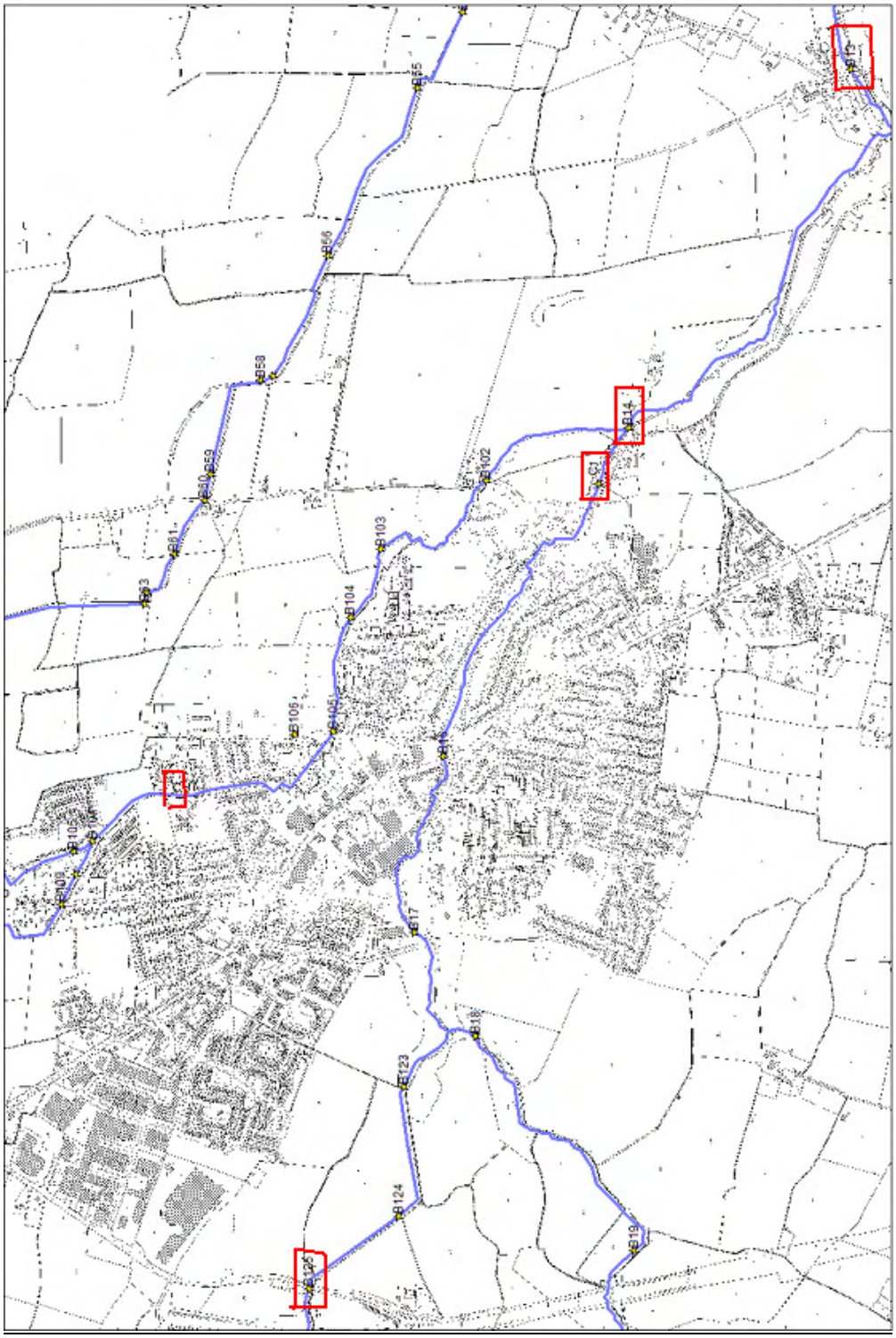


Figure E.3 Ashbourne Area (source: the OPW)

Appendix F List of Reports prepared for this project

Appendix F: List of reports prepared for this project

1. **Inception Report, December 2008**
2. **Preliminary Hydrology Report, February 2009**
3. **SEA Scoping Report, June 2009**
4. **Hydrology Report, February 2010**
5. **Preliminary Option Report, December 2010**
6. **Flood Defence Asset Database, October 2010**
7. **Appropriate Assessment Screening Report, April 2011**
8. **Hydraulics Report, September 2011**
9. **Draft Final Report, September 2011**
10. **SEA Environment Report, September 2011**
11. **SEA Statement**

Figure 1 Hydraulic model schematisation showing 2D model domains and ISIS Reservoir Units

Fingal County Council
Comhairle Contae Fhine Gall

OPW
The Office of Public Works
Oifig na nOibreacha Poiblí

HalcrowBarry