3 Alternatives Considered

3.1 Introduction

This chapter of the EIAR outlines the "various reasonable alternatives", as defined in the Draft Guidelines on the Information to be contained in Environmental Impact Assessment Reports (EPA, Draft August 2017) that were considered for the proposed scheme and provides an indication of the main reasons for selecting the chosen option including a comparison of the environmental effects.

The alternatives considered relate to:

- the flood risk management measures including their location and design;
- the detail of the selected measures;
- construction methodologies.

3.1.1 Background

As discussed in **Chapter 2** *Background and Need for the Scheme,* Arklow has experienced recurring flooding problems that have caused widespread damage to public and private property. The largest flood event recorded was in August 1986 resulting from extreme meteorological conditions commonly referred to as "Hurricane Charlie." Further recent flooding events occurred in December 1989, November 2000, February 2002 and in October 2004, October 2005, January 2010, January 2013 and December 2015.

After the flood events in 1989 and 2000, investigations were carried out into a number of short- and long-term flood risk management measures for Arklow. These measures generally consisted of:

- increasing the conveyance through Arklow Bridge and providing a levee embankment; *and*
- flood defence walls to prevent ingress into the Ferrybank, River Walk and South Quay areas of Arklow.

None of these measures were implemented at that time.

Following the appointment of engineering and environmental consultants, further assessments of potential flood risk management measures were carried out. **Section 2.3** of **Chapter 2,** *Background and Need for the Scheme* describes consideration of constraints, technical assessments and environmental studies that were undertaken to develop measures for further examination. This chapter describes the process of screening measures as being suitable for further consideration and the technical and environmental comparison of these remaining reasonable alternative flood relief measures by means of a multi-criteria analysis (MCA) to identify an emerging preferred option.

This MCA and the preferred option were then described in the Feasibility Study Report, (BLP 2017)[1]. **Section 3.5** of this EIAR describes the consideration of technical and environmental issues associated with the subsequent modifications to the preferred option.

3.2 Do-Nothing Alternative

The first alternative scenario which was considered early in the design process was the 'do-nothing scenario'; i.e. the maintenance of the existing environment in Arklow with no flood defence measures proposed.

The do-nothing scenario was disregarded early in the consideration of alternatives in that, in order to mitigate against the recurring flooding in Arklow, as described in Section 2.2. of **Chapter 2**, '*Background and Need for the Scheme*, it was determined that flood defence measures were required to be designed and implemented. Further, it was determined that the do-nothing scenario would not result in the achievement of the scheme objectives as described in Section 2.4 of **Chapter 2**, '*Background and Need for the Scheme.*'

As previously outlined, the town of Arklow has, for many years, experienced recurring flooding problems that have caused widespread damage to public and private property. In the future, the risk of flooding in Arklow may also increase. Future changes which have the potential to increase the risk of flooding include:

- Climate change resulting in higher rainfall, increased river flows and higher tide levels.
- Geomorphological processes, such as sediment transport, which affects the area of conveyance of the river channel, and erosion.
- Development within the catchment of the Avoca River and its tributaries, which does not conform to the principles of sustainable drainage, and which adversely affects the response of the catchment to rainfall; *and*
- Changes in land use, including forestation and land drainage.

Without intervention, Arklow faces the continued onset of a range of issues associated with flooding including:

- Damage to residential and non-residential properties and consequent financial losses.
- Damage to infrastructural utility services and consequent financial losses.
- Risks to the health and safety of the population living in high flood risk areas including stress and anxiety.
- Disruption and disturbance such as evacuations, traffic diversions, etc.
- Risk of environmental pollution such as runoff of hydrocarbons from flooded areas.

[1] BLP (2017) Avoca River (Arklow) Flood Relief Scheme – Feasibility Study Report (July 2017)

- Restrictions on development in the flood prone areas.

In conclusion, the Do-Nothing Alternative is not a reasonable alternative as it does not address recurring flooding events in Arklow and it does not meets the scheme objectives.

3.3 Screening Assessment of Flood Alleviation Measures

3.3.1 Flood Risk Management Measures Considered During Screening

Sixteen flood risk management measures (F1 to F16) were originally identified and assessed on technical, economic, social and environmental criteria and presented in the Feasibility Study for the Avoca River (Arklow) Flood Relief Scheme Report of September 2013 (BLP). In early 2015, eight further measures (F17 to F24) and combinations of measures were considered. The examination of some of the measures in early 2015 involved a more detailed technical evaluation using more sophisticated hydraulic modelling of measures than previously considered. All of the above measures are listed in **Table 3.1** below. The associated Figures are contained in **Appendix 3.1.**

Table 3.1: Summary of Possible Measures

No.	Description	Figure
F1	Catchment management	-
F2	Upstream storage – single location	Figure F2
F3	Upstream storage – multiple locations	-
F4	Flood storage at Arklow Town Marsh	Figure F4
F5a	Flood relief channel/bypass channel through Arklow town – Option a	Figure F5a
F5b	Flood relief channel/bypass channel through Arklow town – Option b	Figure F5b
F6a	Flood relief channel/bypass channel upstream of Arklow town – Option a	Figure F6a
F6b	Flood relief channel/bypass channel upstream of Arklow town – Option b	Figure F6b
F7	Channel and bank maintenance	Figure F7
F8	Channel deepening through Arklow (dredging)	Figure F8
F9	Local downstream widening of river at contraction location	Figure F9&F20
F10	Debris trap	Figure F10
F11	Removal and replacement of Arklow Bridge	-
F12	Minor improvements to Arklow Bridge	-
F13	Flood containment with flood defence walls and embankments	Figure F13
F14a	Tidal barrage – Option a	Figure F14a

No.	Description	Figure
F14b	Tidal barrage – Option b	Figure F14b
F15	River barrage	Figure F15
F16	Drainage system, non-return valves and pumping	-
F17	Lowering floor of Arklow Bridge by depth of 0.6m (B1)*	Figure F17
F18	Lowering floor of Arklow Bridge by depth of 1.0m. (B2)*	Figure F18
F19	Lowering floor of Arklow Bridge by depth of 1.5m (B3)*	Figure F19
F20	Local downstream widening of river at contraction location (C)*	Figure F9&F20
F21	Lowering floor of Arklow Bridge by 1m and local upstream dredging (D)*	Figure F21
F22	Lowering floor by 1m, and downstream widening at contraction location (E)*	Figure F22
F23	Lowering floor of Arklow Bridge by 1m, downstream widening and upstream and downstream extensive dredging (F)*	Figure F23
F24	Lowering floor of Arklow Bridge by 1.5m, downstream widening and upstream and downstream extensive dredging (G)*	Figure F24

* Letters refer to options in the *Hydraulic Modelling Options Report* June 2015.

3.3.2 Options Screening Workshop

A workshop was held in Arklow on the 16th of July 2015 to carry out a screening of previously identified potential flood relief measures for the Arklow Flood Relief Scheme (as identified in **Table 3.1**) so as to identify the measures to be carried forward for further assessment. The measures addressed at the workshop included those discounted at earlier project development stages to confirm their exclusion was still considered to be appropriate. The workshop was attended by:

- Wicklow County Council;
- Office of Public Works;
- Byrne Looby;
- Arup; and their sub-consultants:
- Brady Shipman Martin (Landscape & Visual), Courtney Deery (Heritage) and Natura Environmental (Biodiversity)

The process followed in the workshop comprised:

- Review of all measures previously considered for the Arklow Flood Relief Scheme;
- Discussion of these measures to determine their suitability for the scheme considering technical, economic, social and environmental factors;
- Decision on measures to be screened out and the reasons for the decision;
- Confirmation of measures to be carried forward for further consideration;

- Agreement on combinations of measures to be included in options to be assessed using the multi-criteria analysis matrix methodology.

This consideration of the options and its outcome was recorded in an options screening report[2] (BLP 2016). A summary of the outcome of that process is set out in **Table 3.2** overleaf.

[2] Byrne Looby: Avoca River (Arklow) Flood Relief Feasibility Study Report on Options Screening Workshop (August 2016)

Table 3.2: Summary of Screening Process of Possible Measures

F1: Catchment Management Catchment management involves river maintenance and the implementation of current best practices for drainage in all future development such as Sustainable Urban Drainage Systems (SUDS) and should be carried out in accordance with the Water Framework Directive's River Basin Management Plan. This would include measures like surface water retention, water treatment and rainwater harvesting. These will reduce the impact of surface water run-off from new developments on the Avoca River, improve the quality of the water being discharged to the river and reduce the overall potable water demand in the area.	
Technical	Catchment management is a non-structural flood risk management measure which would be implemented through planning and development policies and would address future flood risk in conjunction with other measures only. It would not address the existing flood risk.
Economic	There would be no direct cost to the scheme. Costs would be directly linked to the associated development projects.
Social	No significant issue anticipated.
Environmental	There would be no significant impacts anticipated due to implementation of the catchment management plan and measures to protect water quality and catchment habitats.
Conclusion	This is not a measure that would be selected on its own. However, it would be an important measure to reduce flood risk from future development and therefore should be adopted in conjunction with other measures.
F2 – Upstream storage - single location This measure would involve restricting the flow in the Avoca River through Arklow by attenuating flows upstream of the town. Four potential sites (A, B, C & D) were identified. The total volume of impoundments assessed varies from 2,725,000 m^3 (Impoundment B – Option 2) to 14,866,000 m^3 (Impoundment D). A reliable flood forecasting system would be required to maximise the volume of emergency storage available and determine the optimum time when gates should be closed, etc.	
Technical	a) Upstream storage will not work as a standalone measure as it will not protect the town from coastal flooding. b) Permanent maintenance, supervision and monitoring of structures would be required. c) Using the impounded water bodies for other uses (e.g. hydro energy), would impact on the effective storage of the impoundments as some of the capacity would be utilised to serve these functions. d) Some options would require realignment of roads and/or railway line and impact other infrastructure.
Economic	a) The capital cost of the proposed impoundments would be significant and there also be significant costs for maintenance and operation. b) Significant CPO and wayleave issues.
Social	Impacts on community may result from property impacts and associated severance. An impoundment may provide amenity benefit.
Environmental	a) Construction in the river will potentially be detrimental to water quality with potential fish kills and bankside vegetation growth inhibition. b) Potential destruction of local ecology by new water body creation. c) Nitrification of the water when being stored could cause fish kill when water is released. d) Possible impact to groundwater. e) The section of the Avonmore River potentially affected also contains important fisheries habitat including salmonid spawning habitat, which would be impacted by the proposed reservoir. The Annex I habitat "Watercourses of the plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation" may be present along the affected section of the river valley and would be negatively affected.

	f) Ecology impacts are likely to be significant (an impact that alters a sensitive aspect of the environment) or profound (an impact which obliterates sensitive characteristics), in accordance with the impact significance criteria defined in the Guidelines on the Information to be Contained in Environmental Impact Statements (EPA, 2002). g) The development of one or more upstream storage areas could give rise to significant negative landscape and visual impacts. Post-construction, the storage areas could provide recreational amenity and increase landscape and visual diversity and interest.
Conclusion	This measure was discounted based on the potential for significant environmental impacts, coupled with the technical difficulties and the high economic costs.
F3 – Upstream storage - multiple location This measure involves the attenuation of flows at regular intervals along the river channel. It would require increasing the existing channel roughness coefficients and widening the existing river channel in an effort to maximise the river's storage potential upstream of Arklow Town. The volumes of attenuation required would be the same as those outlined under F2 above.	
Technical	The further assessment of this measure would require significant further investigations, but it is unlikely that it would be sufficient on its own to prevent fluvial flooding and it will offer no protection from coastal flooding.
Economic	Significant economic cost.
Social	No significant issue anticipated.
Environmental	a) Periodic temporary alteration of visual aspects of the Avoca Valley. b) Potential damage / alteration of local ecology by flood water storage areas. c) Reduction of agricultural / forested land in Avoca Valley by allowing areas to be used for temporary storage. d) Water pollution directed to flood storage areas can create areas of contaminated land subsequent to drying. e) Polluted flood water has the potential to become stagnant in flood storage area and create odour problems. f) Possible impact on groundwater. g) Ecological impacts could potentially be significant (an impact that alters a sensitive aspect of the environment) or profound (an impact which obliterates sensitive characteristics), in accordance with the impact significance criteria defined in the Guidelines on the Information to be Contained in Environmental Impact Statements (EPA, 2002). This will depend on the type and scale of measures proposed and the sensitivities of the ecological receptors impacted. h) There is potential for significant ecological impacts. i) Localised widening the existing river channel may give rise to short to medium term negative landscape and visual impacts.
Conclusion	This measure was not taken forward for further consideration based on; i. The potential for significant environmental impacts; ii. The storage volumes on its own would not be sufficient to prevent fluvial flooding; iii. Significant economic cost.
F4 – Flood storage at Arklow Town Marsh Currently the Arklow Town Marsh provides online flood storage and flood conveyance. The existing online storage will fill in advance of the flood peak and this will provide minimal attenuation at critical flood peak. In this measure it was proposed to use the marsh as an offline storage system as this is the most efficient method of utilising the limited storage area. The total storage available in the marsh to 3.5 m OD is approximately 1,890,000 m^3 and this provides 38 minutes of storage at peak flood rate of 835 m^3/sec, which is small in relation to the duration of the flood hydrograph but offers some slight attenuation effect. The available storage volume has the capability of reducing the flood peak from 835 m^3/sec to 746 m^3/sec. To provide offline storage at Arklow Town Marsh the following structures are required: i. An upstream lateral weir 200 m long at crest level of 3.9m; ii. An embankment approximately 3,890m long with a proposed top of embankment of 3.9m OD + 0.5m freeboard;	

iii. An outlet structure consisting of a minimum of 6 No. gates capable of emptying the marsh over a 24 to 48-hour period; iv. An overflow spillway to prevent flood levels exceeding embankment heights; and, v. System of drains to allow for draining the marsh after flood storage. vi. It should be noted that for majority of its length the proposed embankment would have to be 3.5m high.	
Technical	This measure will not limit coastal flooding or will not be enough on its own to prevent fluvial flooding. Insufficient storage for protection for any realistic period of time. Will not address coastal flooding.
Economic	Significant cost for very little benefit.
Social	No significant issue anticipated.
Environmental	a) The Arklow Town Marsh is a proposed Natural Heritage Area. Engineering works that alter the ecology of the marsh could have adverse impacts on the habitats within this area. b) Construction of a weir within the river channel could form a barrier to passage of salmonid fish which would be detrimental to fish population in the upstream catchment of the Avonmore River. c) Potential pollution of marsh and detriment to local ecology of the marsh; d) Ecological impacts are likely to be significant (an impact that alters a sensitive aspect of the environment) or profound (an impact which obliterates sensitive characteristics) depending on the design and implementation of this flood relief measure e) Permanent alteration of floodplain ecology; f) Temporary alteration of local landscape during a flood event. g) Works would have significant short to medium term negative landscape and visual impacts.
Conclusion	Given the potential negative environmental impacts, coupled with the fact that the measure on its own makes a relatively minor contribution to the prevention of fluvial flooding, it was decided to discount the measure.
F5 – Flood relief channel/ bypass channel through Arklow town This measure would involve the construction of a flood flow diversion channel through north Arklow. The purpose of the diversion is to reduce the flow through Arklow and hence mitigate fluvial flooding, particularly upstream of Arklow Bridge. Three potential channels were examined in detail (Routes 1 – 3), two through Ferrybank and the other extending from the N11 Bypass Bridge north of Ferrybank to join Webbs River. A new channel could introduce coastal flooding to Ferrybank. New bridges and a new road system around a new river channel would be required.	
Technical	The proposal to construct a by-pass channel and culvert would require significant engineering intervention both alongside and within private properties and would impact permanently on private properties. Would not defend against coastal flooding.
Economic	The estimated costs for such a measure are estimated to be significant.
Social	Significant disruption to the local population during construction.
Environmental	a) The three routes proposed have a potential for the discovery of significant subsurface archaeological remains in the lands along the coast where the outflows will be and in the intertidal zone and on the sea bed b) Possible saline intrusion to the marsh. Construction of flood bypass channel on the north side of the river, upstream of the town, would have adverse impacts on the Arklow Town Marsh pNHA. c) The infrastructure requirements including the channel, roads and bridges, could give rise to significant visual impact for nearby properties.
Conclusion	This measure was discounted due to the significant cost and social and environmental impact.

F6 – Flood relief channel/ bypass channel upstream of Arklow town This measure would involve the creation of extensive flood relief channels directing flood flow from the upper catchment through the Wicklow Mountains in an easterly direction to smaller catchments on the eastern seaboard. The physical dimensions of the Avoca River Valley and the Wicklow Mountains pose significant limiting factors for relief channel route optioneering. The protected status of the Wicklow Mountains and the Avoca River Valley further constrain the positioning of potential diversion points and routing of channels. Potential routes for flood relief channels extending from the Avoca River to the eastern seaboard between "The Meeting of the Waters" and Arklow were also assessed. However, the area along the eastern flank of the Avoca Valley has a significant array of abandoned mining complexes. This area has been noted to be heavily contaminated and both groundwater and surface water resources in this area have been severely impacted. The positioning of diversions points along this stretch of the Avoca Valley would pose a significant risk to the eastern seaboard catchments if contamination spread from this area. As such, diversion channels from the Avoca River to the eastern seaboard catchments from this stretch of the valley were not considered. Consequently, just three flood relief channels extending from the Avoca River, through the Wicklow Mountains to catchments farther north than the Avoca were considered.	
Technical	a) Significant channel diversion works required. b) Would not defend against coastal flooding
Economic	The estimated costs for this measure are estimated to be significant.
Social	Community impacts due to significant CPO and potential severance.
Environmental	a) Ecological impacts, especially impact on the fish habitats could potentially be significant or profound depending on the design and implementation of this measure. Parts of the Avonmore River and its tributaries are designated as an SAC and SPA and are within the Wicklow Mountains National Park. Any adverse impacts on the conservation objectives of these sites would constitute a significant adverse impact. b) The measures proposed will likely have significant landscape and visual implications in areas identified as being of recognised landscape sensitivity and which come under the influence of protected views and prospects. c) Possible significant impact to subsurface and riverine archaeological remains.
Conclusion	On the basis of these potential impacts this measure was discounted.
F7 – Channel and bank maintenance This involves the removal of unwanted vegetation and deposited material from the Avoca River channel and its banks downstream of the M11 Bridge as far as Arklow Bridge to maintain the design channel and bank roughness coefficients. The hydraulic model is sensitive to variations in the roughness coefficients of the channel and banks so it is therefore important to maintain the channel and banks free of unwanted vegetation as their presence could potentially decrease the flow capacity of the river. It is estimated that these works would need to be carried out every five years.	
Technical	This measure would not alleviate flooding in Arklow but would help to ensure that the potential for future flooding is not heightened.
Economic	No significant cost but little economic benefit.
Social	No significant issue anticipated.
Environmental	a) Ecological impacts on woodland and fisheries could potentially be significant or profound depending on the scope and implementation of this measure. Requires further assessment following definition of the scope of the works. Any adverse impacts on the Arklow Town Marsh pNHA could be significant especially if the habitats concerned are altered. b) Temporary and short-term visual impacts associated with the in-channel removal of gravel and stone deposits, removal of bankside vegetation, and possible loss of mature trees. c) Archaeological monitoring would be required.
Conclusion	This measure is retained but only in conjunction with other measures.

F8 – Channel deepening through Arklow (Dredging) The existing Arklow Bridge, due to its geometry, causes a flow restriction in the river channel. During flood events, water levels upstream of the bridge are increased because of this flow restriction. The hydraulic model sensitivity tests show that decreases in the level of the bed (i.e. dredging) at the bridge (the bridge floor) would significantly reduce the impact on flood risk areas immediately upstream of Arklow Bridge by increasing the flow conveyance capacity through the bridge. This measure was examined in more detail in 2015 using a more refined model as described under F22 below. This measure is retained and may be adopted in conjunction with other measures.	
Technical	Refer to sections described under F22 below
Economic	
Social	
Environmental	
Conclusion	
F9 – Channel modification Downstream of the Arklow Bridge (~380 m) there is a pinch point in the Avoca River where the South Quay Road impinges into the river channel which reduces the channel width. The removal of the pinch point would widen the river channel at this location by up to 10m. This measure was examined in more detail in 2015 using a more refined model as described in section F23 below. This measure was retained and may be adopted in conjunction with other measures.	
Technical	Refer to sections described under F23 below
Economic	
Social	
Environmental	
Conclusion	
F10 – Debris Trap The objective of a debris trap is to contain large floating debris, such as trees or branches and to prevent debris build-up at the existing Arklow Bridge and subsequent restriction on flood conveyance capacity. The hydraulic modelling estimated that blockage of one third of the arches of Arklow Bridge would increase flood levels upstream of the Bridge by 825mm for the 1% Annual Exceedance Probability (AEP) event (also referred to as a 1 in 100-year event) in the existing situation or by 700mm in the situation where the bed level was lowered by 1.0m. As a consequence, in the absence of a debris trap, the freeboard for flood defences upstream of Arklow Bridge over the design flood level would need to be increased. The debris trap would involve the construction of columns in the river channel (at shorter separation distances than the Arklow Bridge piers) to allow collection of debris upstream of the bridge. This would need to take place where the river channel and floodplain is adequately wide so as to accommodate a bypass channel around the trap so that flows are not restricted by any build-up of debris. A number of locations were considered for a debris trap. The initial location considered for the debris trap is approximately 215m downstream of the M11 Arklow bypass bridge. This location is outside of the pNHA and has sufficient space to accommodate a bypass. A new access road would have to be constructed via existing lands to the north of the river. An alternative location for the debris trap is approximately 530m upstream of Arklow Bridge. This location is also outside the pNHA and has sufficient space. Access to this debris trap would be by the existing road on River Walk.	
Technical	Reduces risk of blockage and hence reduce the amount of freeboard required for flood defence walls and embankments.
Economic	The cost would not be significant and would result in lower costs for walls and embankments.
Social	No significant issue anticipated.
Environmental	a) No significant direct adverse ecological impact anticipated when the debris trap is located outside the pNHA. b) This measure may have some potential adverse impacts on fish passage depending on the design of a bypass or fish pass.

	c) The measure will have a permanent moderate to significant visual impact. Construction will involve considerable in-stream works that will give rise to significant but localised short-term landscape disturbance and visual impacts. d) It is possible that subsurface archaeological evidence for human activity may come to light during any engineering or earthmoving works associated with debris traps
Conclusion	It was agreed at the workshop to retain this measure but to investigate all locations between the M11 and the marsh to identify the preferred location based on minimising impact and ensuring ease of access to clear trapped debris. To be used in conjunction with other measures.
F11 – Removal and replacement of Arklow Bridge Arklow Bridge is a nineteen-arch arch, 152 metre span, masonry bridge dating back to 1746. The bridge, due to its geometry, causes a flow restriction in the river channel and during flood events, water levels upstream of the bridge are increased because of this flow restriction. A hydraulic model was created with the existing Arklow Bridge removed and replaced with a new bridge that causes no restriction of river flows. The results of the model showed an overall reduction in peak flood levels upstream of the bridge of 0.86m. The new bridge would be provided with soffit levels above the peak design flood level with a reduced number of new piers in order to increase the conveyance area as much as possible. However, the level of the bridge deck at the north and south bank would have to be ramped to tie into the existing pavement levels (existing pavement levels could not be raised due to proximity of existing properties). Due to the requirement to tie into existing pavements levels, the new bridge would have to be closed during significant flood events.	
Technical	Technically, this option would provide a significant improvement in flood flow conveyance.
Economic	A new clear span bridge has a very high estimated cost.
Social	The demolition of the existing bridge and apron would mean removal of the only road and pedestrian link between the north and south sides of Arklow Town during the period of construction and it would also involve major service diversions.
Environmental	a) The removal and replacement of this protected structure and key landmark feature of Arklow would have a profound impact on the streetscape and is not considered a viable option from a cultural heritage perspective. b) There is a high potential for uncovering previously unrecorded bridges, or other fording points, beneath or in proximity to this bridge c) The proposal to remove and replace the bridge will give rise to permanent significant long-term negative impacts in terms of townscape character and setting and visual impacts
Conclusion	Due to the above, this measure was discounted.
F12 – Minor modifications to Arklow Bridge In their structural assessment of Arklow Bridge's lateral capacity, the University of Sheffield[3] concluded that the bridge is capable of withstanding the lateral forces arising from a 1 in 100-year fluvial flood event (200 year combined). Their calculations indicate a significant margin of safety against sliding for all of the bridge piers thereby ruling out the requirement for underpinning of the piers in terms of the design hydraulic loads. Their report does recommend regular re-pointing of the pier mortar joints in order to guard against damage from internal erosion. The University of Bradford[4] report on the scour potential at the bridge recommends extending the existing scour apron to cover all scour prone areas identified in their report. A concrete apron should be constructed across the full width of the river upstream of the bridge. On the downstream end there is an existing concrete apron, and this should be lengthened. Re-pointing of the pier mortar joints and extending the bridge's scour apron will not increase the flood flow capacity under the bridge but both are necessary to maintain the bridge's structural stability and are therefore essential.	
Technical	No benefit to flood alleviation.
Economic	Minor cost.
Social	No significant issue anticipated.

[3] University of Sheffield (2011) Arklow Bridge. Load Carrying Capacity Rev-A
[4] University of Bradford (2010) Arklow Bridge – Assessment of Scour Potential

Environmental	a) This involves works on the protected bridge structure. The works would be required to be undertaken in a manner that will not detract from the aesthetics of the bridge, the natural environment and to not appreciably affect the above water physical and visual appearance of the bridge. b) Any modifications to the bridge would take account of the possibility of there being an earlier concealed historic structure and would have the appropriate specialist present to inspect the work. c) As modifications would be completed in conjunction with other measures, it is possible that subsurface archaeological evidence, such as previously unrecorded and submerged river crossings, or stray finds representing human activity, may come to light during any dredging works of the river.
Conclusion	Recommended for the purposes of bridge maintenance only. Required in conjunction with other bridge modification measures.

F13 – Flood defence walls, embankments, local ground raising and flood gates

Flood containment involves raising the ground levels along the banks of the Avoca River in areas that are at risk of flooding. The extent and type of flood containment is described below.

F13(a) – coastal Flood Defence: Flood Walls

Flood defence walls are necessary to provide protection from coastal flooding downstream of Arklow Bridge in the absence of a tidal barrage. Flood defence walls are required on the south bank of the river from Arklow Bridge downstream as far as the dock. The proposed top of wall levels would be set at the estimated design flood level plus 0.5m for freeboard. The typical height of wall would be approximately 1.2m along the south bank. Flood containment walls with hand railings are required around the dock area with a proposed top of wall level of 1.15m. Local ground raising would also be required in the dock area east of the lifeboat house to allow car access. Floodgates are required in four locations in the dock area. Two 1m floodgates are required along the walls of the lifeboat house and a 6m flood gate is required to allow access to the docking area. There is also the need for an 8.5m flood gate at the shipyard gate and an 8m gate at the slipway.

All of these flood gates, except the slipway flood gate, are to be self-raising that use the approaching floodwaters to automatically raise the barrier. The automatic operation makes this type of defence ideal for unmanned sites. In addition, a protocol should be developed for checking and maintaining the flood gates to ensure that they will be operational in the event of a flood. This would include the inspection of these flood gates during a flood event.

F13(b) – Fluvial Flood Defence: Flood Walls and Embankments

Flood defences are necessary to provide protection from fluvial flooding in the absence of other very significant measures. A fluvial flood containment wall is required upstream of the Arklow Bridge on the river's south bank along River Walk. The predicted design flood level plus freeboard along the River Walk could be approximately 2.15m above the existing road in the absence of other flood alleviation measures. This represents a significant visual impact; therefore, a raised pedestrian area would be constructed to allow a finished height of 1.15m to be constructed along River Walk. Flooding events have affected properties in Ferrybank when flows were conveyed through the marsh. To prevent this from occurring, earth embankments would be constructed to ensure that all properties below the predicted design flood levels are protected. The earth embankments would be constructed at side slopes of 1:2 with a 2.5m wide flat crest at the tops of the embankments to facilitate their future maintenance. As is the case with the coastal and fluvial flood walls, the top level of the embankments would be set at the predicted design flood levels plus freeboard and an allowance for settlement. It is necessary to terminate the earth embankment at the back of the property to the north-west of Arklow Bridge. The levels in this area are still below the design flood levels but the embankment cannot be constructed here because of space constraints. Therefore, a concrete flood containment wall will be constructed along the property boundary up as far as the bridge. The concrete wall would be clad on both sides with a suitable masonry cladding.

Technical	A suitable measure for protection against flooding and necessary to provide protection from the 1% AEP flood event in conjunction with most other measures.
Economic	Typically, costs would be within the acceptable cost-benefit envelop.
Social	Construction may impact the amenity value in the area.
Environmental	Tidal Flood Walls a) The original quay walls will not be visible as a result of the proposed works resulting in an adverse impact on industrial heritage.

	b) There is a potential that subsurface archaeological features may come to light during the proposed construction of walls and embankments. Proximity to the zone of archaeological potential for Arklow Town (RMP WI040-029) increases this potential. c) At South Quay given the proximity of properties, construction impacts will be significant. Thereafter, landscape and visual impacts will be permanent and significant along the western end of South Quay where the proposed walls will effectively cut off existing views to water. The finish of proposed walls be important in mitigating impacts. Fluvial Flood Walls a) Construction of the embankment will result in significant landscape disturbance and visual intrusion for the properties along Ferrybank. Longer-term impacts will not be significant. b) During construction the barrier has the potential to have significant townscape and visual impact on the riverside amenity at River Walk.
Conclusion	As flood defence walls and embankments are required in conjunction with most other options, these measures are retained for further consideration.
F14 & F15 – Tidal Barrage and River Barrage Further to the Environmental Assessment of Options Workshop that took place on 10th March 2008 measures F14 & F15 have been merged into one. This measure consists of the following structures: i. A tidal barrage located at the mouth of the Avoca River; ii. A fluvial barrage located upstream of the town; and, iii. An embankment around the marsh. In times of high tides, the tidal barrage would be closed, protecting the town from flooding. At the same time the fluvial barrage would also have to be closed and fluvial flow stored in the marsh. The proposed 52m long tidal barrage would be located at the mouth of the Avoca River to prevent coastal flooding of Arklow. Estimated 200-year tides are as follows: i. 1.56 mOD without sea level rise (climate change) ii. 2.06 mOD with sea level rise i. The required barrage level is estimated to be 1.56 mOD + 1m freeboard to allow for wave action.	
Technical	The provision of river and tidal barrages would need to be carried out in conjunction with F5 (Flood relief channel/bypass channel through Arklow) to ensure flood protection from the design flood event is provided. Also the impact of the tidal barrage on fluvial flows and the possible increase in sedimentation during the closure of both barrages would require further investigation if these measures are to be considered further.
Economic	It is estimated that the cost associated with this measure would be substantial and would result in a non-economically feasible scheme
Social	There would be impacts on private property.
Environmental	a) Ecological Impacts due to the introduction of either a tidal or river barrage could potentially be significant or profound due to direct impacts on the river channel and also its operation may have indirect impacts upstream within the catchment. The fisheries habitat is likely to be negatively impacted. b) An embankment around the total perimeter of Arklow Town Marsh pNHA would have permanent adverse impacts on the ecology of this area. c) Significant landscape and visual impacts are associated with either measure, during construction and post construction.
Conclusion	Based on the above, these measures have been discounted from further consideration.
F16- Drainage system, non-return valves and pumping This proposal is to prevent flooding caused by rising river levels backing up through sewers and drains that discharge into the river. Non return valves (NRVs) would be fitted to the discharge pipes to ensure that river flows cannot back up into the sewer networks.	

Drainage systems, pumping stations and rising mains would also be required to prevent flooding occurring via rainwater run-off from hardstanding areas in flood prone zones during periods of high river levels when discharge to the river would be prevented as the NRVs would be in their shut position. The pumps would discharge to the river above the estimated design flood level. In total, 39 NRVs are required on the sewers discharge points. Additional NRVs are also needed to intercept gully connections that discharge directly to the river through the quay walls. It would have little or no negative impact and would have relatively low costs.	
Technical	The measure is required as part of any flood containment option.
Economic	No significant cost.
Social	No significant issue anticipated.
Environmental	The detailed design of the measure will require consideration of impact on the Arklow Town Marsh pNHA and appropriate reinstatement within the town
Conclusion	This measure would not manage the risk on its own but should be used in conjunction with any flood containment measures undertaken. This measure is therefore retained.
F17, F18 and F19 – Lowering floor of Arklow Bridge by depth of 0.6m (B1), 1.0m (B2) and 1.5m (B3) These measures involve lowering of the floor of Arklow Bridge by 0.6m, 1.0m and 1.5m without any associated river dredging works. This would require the existing piers of the bridge to be underpinned in order to carry the foundation of the bridge down to a suitable formation. In addition, a new reinforced concrete floor for the bridge is proposed. Hydraulic modelling of these measures show that there would be a reduction in the design flood levels immediately upstream of Arklow Bridge by 205mm, 280 and 350mm for the 0.6m, 1.0m and 1.5m lowering respectively.	
Technical	These measures on their own would not provide protection from the design flood event. In addition, ongoing maintenance dredging would be required at the bridge to main the channel depth.
Economic	Costs not justified on basis of benefit derived from measure on its own
Social	No significant issue anticipated.
Environmental	a) Dredging of the river, will result in some slight to moderate, localised landscape and visual impact b) It is possible that subsurface archaeological evidence, such as previously unrecorded and submerged river crossings, landing points or stray finds, may come to light during any dredging works of the river.
Conclusion	The use of these measures on their own is not considered further due to the insufficient benefit in flood alleviation but they should be considered in conjunction with other measures.
F20- Local downstream widening of river at contraction location (C) This involves the local widening of the river channel over a length of 160m by up to 10m in width (see F9 above). The slipway and wave break would also be removed. The channel widening would require the realignment and narrowing of the adjacent road and the removal of a local green area. This measure on its own would reduce the 1% AEP flood level by 50mm and 95mm immediately upstream and downstream of Arklow Bridge, respectively. This measure has the benefit of providing more a uniform velocity regime than currently exists. This would result in less sedimentation and thus a slightly lower maintenance dredging requirement and it mitigates against the risk of future increased deposition of dredged material.	
Technical	Provides more uniform velocity profile leading to reduced sedimentation.
Economic	Slight reduction in channel maintenance costs.
Social	Loss of amenity associated with the green area and road traffic closer to houses on South Quay.
Environmental	a) The removal of the pinch point would require the realignment of the South Quay Road and the removal of existing green areas on the western side of the road.

	b) Disposal of potential contaminated sediments may be required. c) The removal of large portions of original, intact quay wall would have a significant heritage impact. d) Potential to reveal significant archaeological remains that are presently buried or submerged. e) Widening of the channel will result in significant localised visual impact and have a long-term adverse impact on the setting of nearby residential properties.
Conclusion	This measure is not considered further on its own due to the very minor benefits in flood alleviation.
F21 – Lowering floor of Arklow Bridge by 1m and local upstream dredging (D) This measure is similar to F18 but with the addition of local upstream dredging of Arklow Bridge. The reduction in the level of the1% AEP flood event would be 264mm immediately upstream of Arklow Bridge.	
Technical	This measures on its own would not provide protection from the 1% AEP flood event. In addition, ongoing maintenance dredging would be required at the bridge to maintain the channel depth. Small reduction in flood levels over F18.
Economic	Ongoing cost for maintenance dredging.
Social	No significant issue anticipated.
Environmental	a) Dredging of the river, will result in some slight to moderate, localised landscape and visual impact b) Dredging of the river could have temporary negative impacts on fish habitats. c) It is possible that subsurface archaeological evidence, such as previously unrecorded and submerged river crossings, landing points or stray finds, may come to light during any dredging works of the river.
Conclusion	Due to the small benefits, this measure is not considered further.
F22 – Lowering floor by 1m, and downstream widening of contraction point (E) This measure is a combination of measures F18 and F20. The reduction in the level of the1% AEP flood event would be 350mm immediately upstream of Arklow Bridge. There would also be an impact due the realigned and narrower road and removal of a green area.	
Technical	These measures on their own would not provide protection from the 1% AEP flood event. In addition, ongoing maintenance dredging would be required at the bridge to maintain the channel depth.
Economic	Small economic benefit.
Social	Loss of amenity associated with the green area and road traffic closer to houses on South Quay.
Environmental	a) Dredging of the river, will result in some slight to moderate, localised landscape and visual impact. b) Dredging of the river could have temporary negative impacts on fish habitats. c) It is possible that subsurface archaeological evidence, such as previously unrecorded and submerged river crossings, landing points or stray finds, may come to light during any dredging works of the river. d) Construction impacts associated with the removal of the pinch point would require the realignment of the South Quay Road and the removal of existing green areas on the western side of the road. e) Disposal of potential contaminated sediments may be required. f) The removal of large portions of original, intact quay wall would have a significant heritage impact. g) Widening of the channel will result in significant localised visual impact and have a long-term adverse impact on the setting of nearby residential properties.
Conclusion	Due to the small benefits, this measure is not considered further on its own but is considered in conjunction with other measures.
F23 – Lowering floor of Arklow Bridge by 1m, downstream widening and extensive upstream and downstream dredging (F) This measure is a combination of options F18 and F20 with the addition of extensive upstream and downstream dredging. The reduction in the level of the 1% AEP flood event would be 480mm immediately upstream of Arklow Bridge.	

Technical	These measures on their own would not provide protection from the 1% AEP flood event. In addition, there would be an impact due the realigned and narrower road and removal of a green area. However, the reduced design flood level upstream of Arklow Bridge would allow the flood defences to be lowered by 480mm over the option with flood containment only.
Economic	Significant costs but would provide significant economic benefit also.
Social	Loss of amenity associated with the green area and road traffic closer to houses on South Quay.
Environmental	a) Dredging of the river, will result in some slight to moderate, localised landscape and visual impact b) Dredging of the river could have temporary negative impacts on fish habitats. c) It is possible that subsurface archaeological evidence, such as previously unrecorded and submerged river crossings, landing points or stray finds, may come to light during any dredging works of the river. d) The removal of the pinch point would result in construction impacts associated with the realignment of the South Quay Road and the removal of existing green areas on the western side of the road. e) Disposal of potential contaminated sediments may be required. f) The removal of large portions of original, intact quay wall would have a significant heritage impact. g) Widening of the channel will result in significant localised visual impact and have a long-term adverse impact on the setting of nearby residential properties.
Conclusion	These measures were retained for further consideration in conjunction with other measures.
F24 – Lowering floor of Arklow Bridge by 1.5m, downstream widening and upstream and downstream extensive dredging (G) This measure is similar to F23 but with the bridge floor reduced in level by 1.5m. The reduction in the level of the 1% AEP flood event would be 540mm immediately upstream of Arklow Bridge.	
Technical	Impacts and benefits would be similar with flood defence walls upstream of Arklow Bridge being lowered by 60mm over measure F23 above.
Economic	Very small economic benefit compared to measure F23 above with significant additional dredging cost.
Social	Loss of amenity associated with the green area and road traffic closer to houses on South Quay.
Environmental	a) Dredging of the river, will result in some slight to moderate, localised landscape and visual impact b) It is possible that subsurface archaeological evidence, such as previously unrecorded and submerged river crossings, landing points or stray finds, may come to light during any dredging works of the river. c) The removal of the pinch point would result in construction impacts associated with the realignment the realignment of the South Quay Road and the removal of existing green areas on the western side of the road. d) Disposal of potential contaminated sediments may be required. e) The removal of large portions of original, intact quay wall would have a significant heritage impact. f) Widening of the channel will result in significant localised visual impact and have a long-term adverse impact on the setting of nearby residential properties.
Conclusion	As the additional lowering of the bridge floor by 500mm only provides 60mm benefit, it was agreed that this measure would not be considered further.

3.3.3 Flood Risk Management Measures Discounted Following Screening

In the initial screening, the flood risk management measures listed below in **Table 3.3** were identified as not meeting the project objectives as described in **Section 2.4** of **Chapter 2**, *Background and Need for the Scheme*, were not regarded as reasonable alternatives and were discounted from further consideration.

Table 3.3: Flood Risk Management Measures Discounted

No.	Description
F2	Upstream storage – single location
F3	Upstream storage – multiple locations
F4	Flood storage at Arklow Town Marsh
F5	Flood relief channel/bypass channel through Arklow town
F6	Flood relief channel/bypass channel upstream of Arklow town
F8	Channel deepening through Arklow (similar to F23 and F24)
F9	Channel Widening (similar to F20)
F11	Removal and replacement of Arklow Bridge
F14	Tidal barrage
F15	River barrage
F17	Lowering floor of Arklow Bridge by depth of 0.6m
F18	Lowering floor of Arklow Bridge by depth of 1.0m
F19	Lowering floor of Arklow Bridge by depth of 1.5m
F20	Local downstream widening of river at contraction location (included with F23)
F21	Lowering floor of Arklow Bridge by 1m and local upstream dredging
F22	Lowering floor by 1m, and downstream widening of contraction point
F24	Lowering floor of Arklow Bridge by 1.5m, downstream widening and extensive upstream and downstream dredging

3.3.4 Flood Risk Management Measures Retained Following Screening

The following is a list of the viable flood risk management measures that were retained for further consideration following the screening exercise:

Table 3.4: Measures Retained for Further Consideration

No.	Description
F1	Catchment management
F7	Channel and bank maintenance
F10	Debris trap
F12	Minor modifications to Arklow bridge
F13	Flood defence walls and embankment

No.	Description
F16	Drainage system, non-return valves and pumping
F23	Lowering floor of Arklow Bridge by 1m, downstream widening and upstream and downstream extensive dredging

3.3.5 Combinations of Measures Retained Following Screening

A number of the retained measures were identified by the screening exercise to form part of all options to be considered. These were:

- F1 - Catchment management
- F7 - Channel and bank maintenance
- F12 - Minor modifications to Arklow Bridge
- F16 - Drainage system, non-return valves and pumping stations

These remaining measures were combined into reasonable options which are listed in **Table 3.5** below:

Table 3.5: Combinations of Measures

Option	Measure(s)
Option 1	F13 - Flood defence walls and embankment on their own
Option 2	F13 & F10 - Flood defence walls and embankment with debris trap
Option 3	F13 & F23 - Flood defence walls and embankment with lowering of floor of Arklow Bridge by 1m, downstream widening and upstream and downstream extensive dredging
Option 4	F13, F23 and F10 - Flood defence walls and embankment with lowering of floor of Arklow Bridge by 1m, downstream widening and upstream and downstream extensive dredging and debris trap

In each of the four options, flood defence walls and embankment were required. The extent and level of the flood defence walls downstream of Arklow Bridge are determined by the coastal design flood level (0.5% AEP flood event). The extent and level of the fluvial flood defence walls and embankment upstream of Arklow Bridge are influenced by the contribution from the other measures being implemented in the particular option.

The widening of the river channel at the local contraction/pinch point (F20) was considered in conjunction with Options 3 and 4. Although it provided very little reduction to the flood levels on its own and had a significant impact on neighbouring residents, it was anticipated to provide a benefit in reducing the requirement for on-going maintenance dredging.

3.4 Multi Criteria Assessment

3.4.1 Overview

A Multi-Criteria Assessment (MCA) workshop was held in late August 2016. The MCA was undertaken for the appraisal of the four reasonable options listed above in **Table 3.5** of **Section 3.3.5**, as identified through the screening process, that would deliver the scheme objectives as described on **Section 2.4** of **Chapter 2,** *Background and Need for the Scheme* of this EIAR.

A multi-criteria assessment was also undertaken for the appraisal of two viable locations for the debris trap.

The appraisal of options was undertaken using the OPW guidance note No.28[5] and involved a multi criteria assessment to provide a consistent approach to the appraisal of flood risk management options. The assessment takes into account the wide range of potential benefits and impacts that flood risk management measures can have.

At noted in Section 1.6.4 of **Chapter 1** *Introduction*, a public information day was held by Wicklow County Council on 8th August 2016 to inform interested parties about the status of the project and to brief them on the progress of the proposed scheme. The key issues (as listed in Section 1.6.4) were communicated to the design team and were considered during the MCA workshop held in late August 2016.

3.4.2 Description of MCA Scheme Options

The following is the list of options considered in the multi-criterial assessment (MCA). The references for the measures making up these options are shown in brackets, they can be seen in the related figures in **Appendix 3.1** and are detailed in **Table 3.2** of **Section 3.3.2**:

Option 1:

i. Flood defence walls and embankment on their own (F13)

Option 2:

i. Flood defence walls and embankment (F13)

ii. Debris trap (F10)

Option 3:

i. Flood defence walls and embankment (F13)

ii. Lowering the floor of Arklow Bridge by 1m (F23)

iii. Downstream widening (F23)

[5] OPW (2013) Guidance Note No 28 - Option Appraisal and Multi Criteria Analysis (MCA) Framework

iv. Extensive upstream and downstream dredging (F23)

Option 4:

i. Flood defence walls and embankment (F13)

ii. Lowering the floor of Arklow Bridge by 1m (F23)

iii. Downstream widening (F23)

iv. Extensive upstream and downstream dredging (F23)

v. Debris trap (F10)

3.4.3 Description of MCA

The appraisal involved the scoring of each viable option against each objective in the multi criteria analysis in relation to the specified minimum requirements and the aspirational targets. This assessment was based on the benefits and the impacts involved in each option. A global and local weighting was assigned to each objective to indicate the importance of each objective to the areas of potential risk in Arklow.

The indicator, minimum requirements and aspirational targets and the global and local weighting were obtained from the OPW Guidance Note No 28 to ensure consistency of appraisal of options in relation to other schemes nationally. There are 4 main criteria in the MCA. These are technical, economic, social and environmental.

The technical section of the MCA scores the different viable options based on how the options are operationally robust and how adaptable they are to future flood risks. This section also takes into account the health and safety risk associated with the construction, operation and maintenance of the flood risk management option.

The economic section is used to assess how the options will minimise the risk to transport infrastructure, agriculture, utilities infrastructure and economic risk.

The options' ability to minimise risk to human health and life, and also minimise risk to the Arklow community, are scored in the social section of the MCA assessment.

The environmental section assesses the options' ability to support the objectives of the Water Framework Directive (WFD) and the Habitats Directive, the ability of the option to avoid damages to flora, fauna and fisheries and where possible to enhance it. The options are also scored on their ability to protect and possibly enhance landscape character and visual amenities within the river corridor. Cultural heritage sites are also taken into account in this section and scores are based on the options' ability to prevent damages to heritage sites.

3.4.4 Comparison of Environmental Effects in the MCA

As mentioned in **Section 1.3.2** of **Chapter 1,** *Introduction,* the 2018 Regulations (S.I. No. 296 of 2018) transpose the requirements of the Directive 2014/52/EU, amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment, into existing Irish planning consent procedures. These Regulations require an EIAR to describe the various reasonable alternatives that were considered for the proposed scheme and provide an indication of the main reasons for selecting the chosen option including a comparison of the environmental effects. This comparison of environmental effects for the reasonable options included in the MCA is summarised overleaf in **Table 3.6**. The topic descriptors used in the 2018 Regulations and this EIAR are used to describe the environmental effects.

The MCA considered largely the differentiating factors in the comparison of environmental and other effects.

For example; with regard to population and human health, all options would provide full protection from the flood risk to residents and any highly vulnerable properties in the area. Similarly, all options would result in disruption to residents for the duration of the works on or adjacent to local roads.

Table 3.6: Comparison of Environmental Effects of Reasonable Alternative Options - Summary

	Option 1	Option 2	Option 3	Option 4
Biodiversity	No impact on SAC, SPA site as a result of scheme Potential for localised loss or disturbance to flora and fauna limited by the already modified nature of the channel/shoreline	No impact on SAC, SPA site as a result of scheme Potential for localised loss or disturbance to flora and fauna limited by the already modified nature of the channel/shoreline; impact slightly increased over option1 due to debris trap	No impact on SAC, SPA site as a result of scheme Potential for localised loss or disturbance to flora and fauna limited by the already modified nature of the channel/shoreline; impact slightly reduced from option one due to smaller footprint of embankment in marsh.	No impact on SAC, SPA site as a result of scheme Potential for localised loss or disturbance to flora and fauna limited by the already modified nature of the channel/shoreline; impact slightly increased over option 3 due to debris trap.
Climate	Suitable for adaptation in response to climate change	Suitable for adaptation in response to climate change	Greater suitability for adaptation in response to climate change	Greater suitability for adaptation in response to climate change
Fisheries	Creation of fisheries potential with reduction of pollutants entering river	Creation of fisheries potential with reduction of pollutants entering river	Creation of fisheries potential with reduction of pollutants entering river and removal of impediment to fish passage.	Creation of fisheries potential with reduction of pollutants entering river and removal of impediment to fish passage
Water Quality	Short term small impact due to construction; Long term reduction in pollution risk	Short term small impact due to construction; Long term reduction in pollution risk	Short term medium impact due to construction and dredging; Long term reduction in pollution risk	Short term medium impact due to construction and dredging; Long term reduction in pollution risk
Landscape Character	Enhancement of local landscape features Adverse effects from construction of hard defences where no defences existed prior	Enhancement of local landscape features Adverse effects from construction of hard defences where no defences existed prior	Enhancement of local landscape features, Adverse effects due to construction of hard defences where no defences existed prior. Less impact than options 1 and 2 due to lower walls	Enhancement of local landscape features, Adverse effects due to construction of hard defences where no defences existed prior. Less impact than options 1 and 2 due to lower walls
Archaeological, Architectural	Potential for minor impact to local architectural features due to walls	Potential for minor impact to local architectural features due to walls	Potential for minor impact to local architectural features due to walls and works on Arklow Bridge	Potential for minor impact to local architectural features due to walls and works on Arklow Bridge

	Option 1	Option 2	Option 3	Option 4
and Cultural Heritage	Potential for minor impact to archaeology due to construction.	Potential for minor impact to archaeology due to construction.	Potential for minor impact to archaeology due to construction; slightly increased over options 1 and 2 due to dredging in river	Potential for minor impact to archaeology due to construction; slightly increased over options 1 and 2 due to dredging in river
Population and Human Health	Significant protection of human lives. Significant improvement in human health.	Significant protection of human lives. Significant improvement in human health.	Significant protection of human lives. Significant improvement in human health.	Significant protection of human lives. Significant improvement in human health.
Material Assets	Private lands to be acquired for embankment in Marsh	Private lands to be acquired for embankment in Marsh	Private lands to be acquired for embankment in Marsh	Private lands to be acquired for embankment in Marsh

3.4.5 Main Reasons for Selecting Preferred Option following MCA

Following the MCA process, Option 4 was selected as the preferred option.

The final decision on the preferred option was made based on a holistic evaluation of the following key aspects:

- Findings of Cost Benefit Analysis.
- Findings of Multi-Criteria Analysis (MCA).
- Consideration of the key issues which arose during the 2016 consultation process.
- Consideration of Key Project Risks and ongoing operational and residual risks.
- Consideration of Climate Change Adaptability; and
- Combined professional judgement of the steering group members in considering how well the options met the project objectives.

The results of the cost benefit analysis indicated that all four options were economically viable.

The MCA process indicated that the social and economic aspects were similar for all options.

Option 4 had the most favourable score for technical aspects. An equal level of flood protection was provided to the community by all options. A greater degree of climate change adaptability was available from Option 3 and 4. Health and safety risks associated with scheme's construction, operation and maintenance was a contributing factor in identifying the optimum solution as Option 4.

Option 3 had the most favourable scope for environmental aspects, followed by Option 4. The adverse environmental impacts, (especially landscape/increased wall heights) were less for Option 3 and 4 than Options 1 and 2, primarily due to the reduced height of flood defence walls and embankments upstream of Arklow Bridge.

Based on the MCA assessment of the four flood alleviation options from environmental, social, economic and technical viewpoints, it was determined that the optimum solution was Option 4.

The benefits associated with the debris trap provision, in terms of minimising flood risk from debris blockage at the Arklow Bridge and protecting the integrity of the bridge, were also key decision-making factors. These benefits were greater than the minor direct adverse effects on biodiversity due to its provision.

The key issues raised during the August 2016 public consultation (as listed in Section 1.6.4 of **Chapter 1** *Introduction*,) were also considered in the selection of the preferred option during the decision-making process at the MCA workshop.

3.4.6 Debris Trap MCA Options

An additional minor MCA process was undertaken for two debris trap locations, described under F10 in **Table 3.2** . These were:

- ***Location A:*** 215m downstream of the M11 Arklow bypass bridge.
- ***Location B:*** 530m upstream of Arklow Bridge.

Location B was initially preferred on account of easier access, minimal environmental impact during construction and maintenance and the possibility of flood flows bypassing the debris trap through Arklow Town Marsh if the debris trap became partially blocked. Subsequently assessments indicated that a gravel trap would be beneficial as well as a debris trap and their location was considered as part of a specialist hydro-geomorphology study in 2019[6]. This further development of the preferred option is discussed below in **Section 3.5.3**.

3.5 Further Development of Preferred Scheme

The measures forming the preferred option presented in the previous section underwent further development and assessment following further technical studies, consultation with stakeholders and consideration of environmental and economic impacts.

These are presented in the following sections below and are shown in the figures in **Appendix 3.1**.

3.5.1 F1 – Catchment management

Further consideration was made through technical progress meetings. This measure is being addressed through Wicklow County Council's planning and development policies which are aimed at reducing future flood risk. As such, this measure is not included directly in the current scheme.

3.5.2 F7 – Channel and bank maintenance

A five-year maintenance plan was proposed in 2015, however further consideration of the geomorphology and the frequency required to achieve their objectives indicated that a maintenance plan of at least once a year is adopted for the scheme. The actual frequency of maintenance is dependent on the amount of gravel and debris transport to the trap locations by flood flows.

3.5.3 F10 - Debris Trap – Relocation and Gravel Trap

A hydrogeomorphology study was carried out in 2019 (GDG 2019) to investigate the likely deposition of river sediment in the modified channel.

[6] GDG (2019) Arklow Flood Relief Scheme – Hydro-geomorphology Study – Hydraulic modelling of the Avoca River

Deposition areas were identified upstream of Arklow Bridge with further possible areas downstream. As a result, a gravel trap to limit deposition along the river was proposed.

That study found that the optimum location for the gravel trap relative to the debris trap was immediately upstream of it. The preferred location of the debris and gravel traps was in the river channel upstream of the proposed dredged area. To minimise disturbance to the habitat and amenity on both the north and south banks it was identified that having one maintenance access for both traps on the south bank was preferred as access from the north bank would impact on Arklow Town Marsh. The preferred location for the traps, to accommodate both access for maintenance and gravel collection which minimised habitat disturbance and visual impact, was at the location of the existing slipway on River Walk. **Figure 3.1** overleaf indicates the relocation of the debris trap and gravel trap from that preferred in the MCA, it being approximately 220m farther downstream than the location considered in the MCA. This final location identified was adjacent to the maintenance access, that resulted in least bankside habitat and amenity loss, and will allow the respective traps to collect the deposited gravel and debris anticipated in the hydrogeomorphology study.

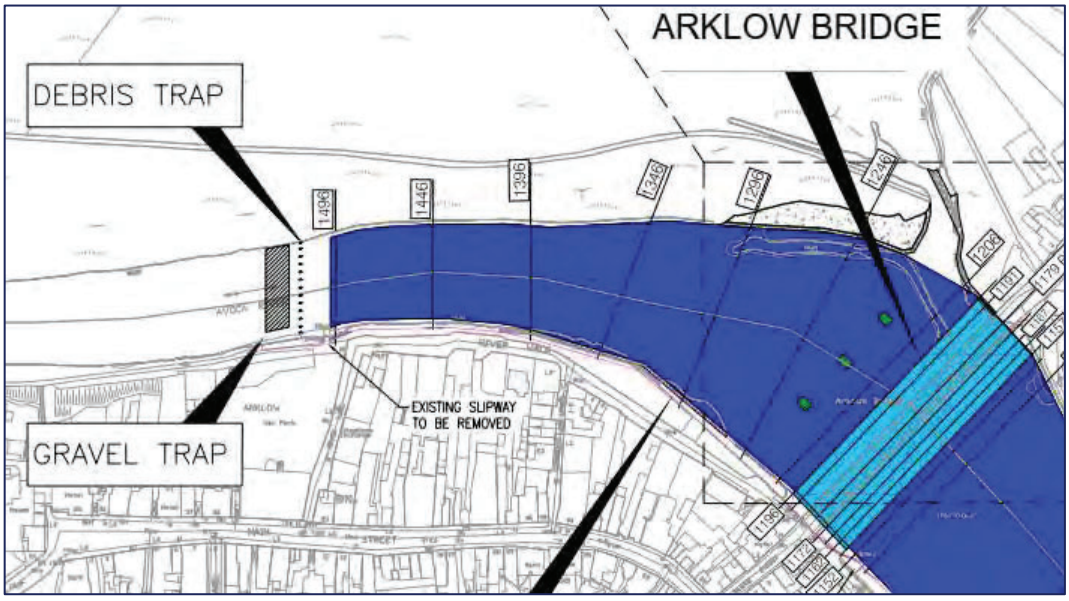


Figure 3.1: Relocation of Debris Trap and Gravel Trap

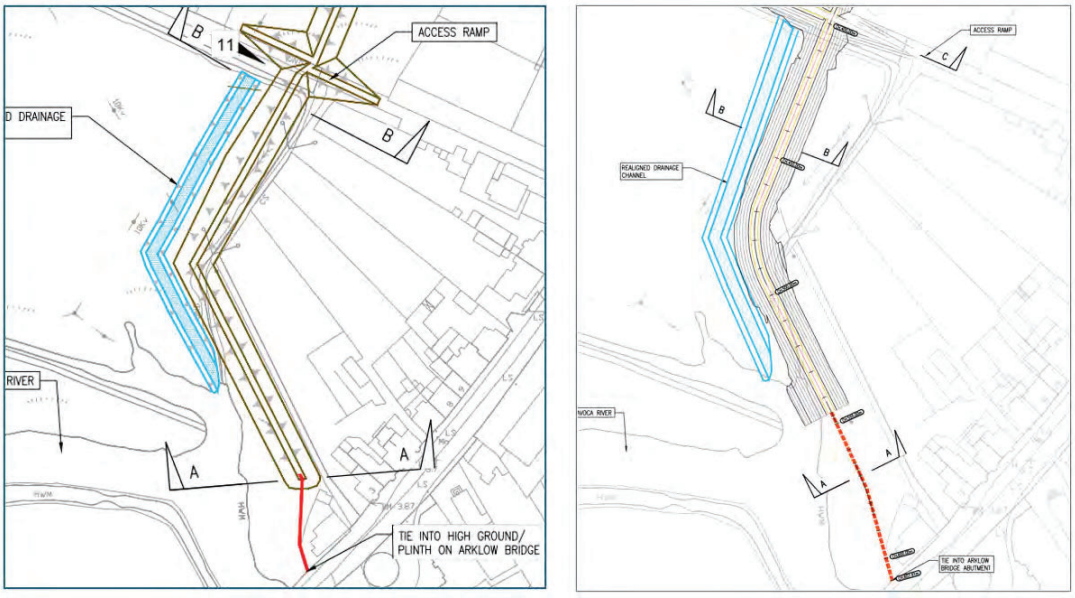
3.5.4 F13 - Flood defence walls, embankments, local ground raising and flood gates

3.5.4.1 Flood Defences – North Bank

Following design development, the extent of the sheet piled wall on the north bank by Arklow Bridge was increased as the construction of an embankment was considered to be difficult in the soft marsh ground adjacent to the river channel.

In addition, following consultation with Irish Water regarding the Arklow WwTP Project, it was evident that the provision of a wall allowed more space for the proposed access shaft for the tunnelling of the Irish Water sewer in the vicinity. The location of the sheet pile wall being progressed is shown overleaf in **Figure 3.2**. The design of this wall was further considered in conjunction with the landscape and biodiversity specialists and its finish, the land-form adjacent and the planting proposed adjacent were developed to minimise adverse visual impacts and to provide native species replanting.

The landscaping at Arklow Marsh (adjacent to the proposed embankment) and the extension to the north riverbank upstream of Arklow Bridge was incorporated into the design to provide some opportunities for habitat creation and mitigation of direct and indirect effects on biodiversity due to the loss of in-river vegetated islands and loss of habitat in the marsh.

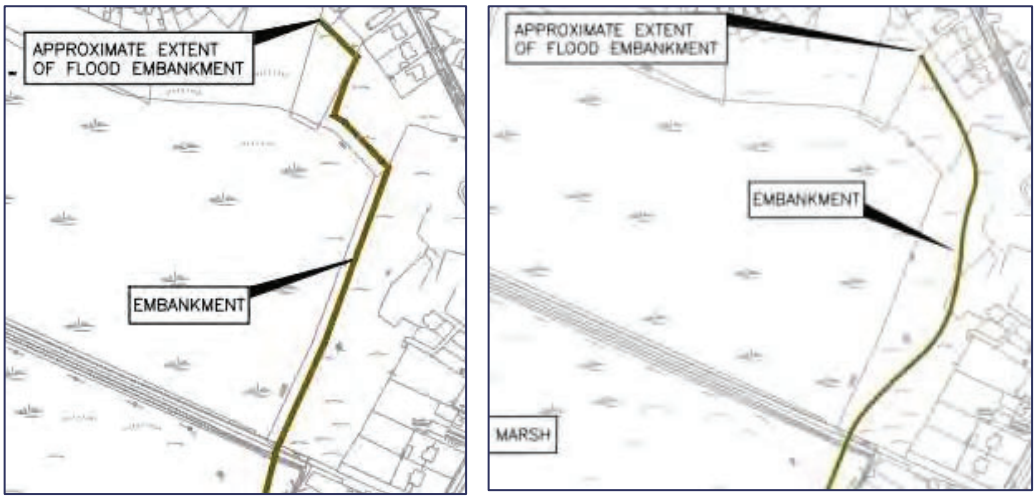


Original option **Selected option**

Figure 3.2: Alternative Designs for Flood Defence Wall at Ferrybank (Not to scale)

Originally, the embankment proposed in the Marsh ran in a series of straight lines from the rear of No.3 Ferrybank to the Dublin Road.

An alternative alignment was developed in consultation with the project landscape architect. **Figure 3.3** below shows the alternative alignment for the embankment. The benefits associated with the introduction of a series of curves to soften its appearance led to the alternative being adopted.



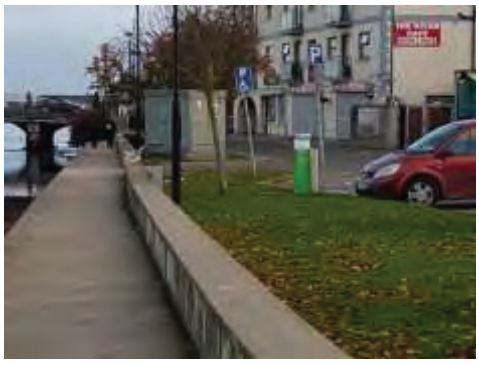
Original option **Selected option**

Figure 3.3: Alternative Alignments for Embankment

3.5.4.2 Flood Defences – South Bank Upstream of Arklow Bridge

The location of the flood defence wall along River Walk was assessed and developed in conjunction with the consideration of the public realm and the further design development of the Arklow WwTP Scheme (sewerage network). In response to public consultation and discussions between stakeholders and the project team, the position of the flood defence wall was developed. As discussed in **Section 1.6** of **Chapter 1**, *Introduction*, in response to public consultation, the public realm design associated with the provision of flood walls was also developed further and is discussed below in **Section 3.5.5**.

At the Feasibility Report stage preferred option, the line of the flood defence wall along River Walk typically followed the line of the existing low wall – see adjacent photograph. A number of factors influenced the decision to modify the alignment of this wall:



A proposed manhole is to be constructed upstream of Arklow Bridge on the line of the new interceptor sewer which is to be laid under the southernmost arch of Arklow Bridge as part of the Arklow WwTP Project. In consultation with the designers for the WwTP Project, the line of the new wall was moved into the river channel to ensure that the proposed manhole was located on the dry side of the flood defence wall.

The construction of the flood defence wall, in close proximity to an existing electricity sub-station on River Walk, presented risks with respect to safety and to damage to the sub-station. The option of relocating the sub-station was assessed and discussions held with the ESB.

It was considered however, to be unviable on account of the number of medium voltage cables connected to the sub-station, the disruption to the electricity supply while relocation works would be underway and the cost of the relocation. It was therefore decided to move the wall to the river side of the footpath, farther from the sub-station.

The required height of the flood defence wall upstream of Arklow Bridge is approximately 1.85m on average above existing ground level. In consultation with the landscape architect and public realm designer, the line of the wall was moved to the river side of the footpath and a raised public realm space created on the dry side of the wall. This will reduce the visual impact of the wall and provide a valuable open space for the public along the river side, with a resultant wall height of 1.15m above pedestrian level. This is further addressed below in **Section 3.5.5**.

The upstream end of the flood defence wall, at the Feasibility Report stage preferred option, terminated in a ramp starting at River Lane. During the development of the public realm design for the proposed Scheme, the integrated design team decided to move the start of the ramp approximately 5m further upstream to allow an open space/amenity area at the River Walk / River Lane junction.

As part of this integrated design development of the public realm aspects of the Scheme, it was noted that the proposed flood defence wall cut off immediate access to the riverbank. In response, it was decided to provide a boardwalk on the river side of the flood defence wall from the upstream extent of the new flood wall downstream for approximately 200m. The boardwalk will be accessible from ramps at either end.

An existing river access point at the River Walk / River Lane junction – see adjacent photograph - will be demolished to allow the construction of the flood defence wall in this area. To mitigate this impact, a new floating pontoon is proposed, to be accessed from the new boardwalk. The pontoon will facilitate launching of rowing boats, kayaks, etc. and will be a more suitable facility than the existing rigid structure.

To mitigate the impact of the flood defence wall on the views of the Avoca River and to facilitate the maintenance of certain key viewpoints, glass panels will be incorporated into the walls at number of locations along River Walk. This includes glass panels at the junction of River Walk and River Lane (Ch 060), the seating area along River Walk (Ch 105) and the elevated terraces upstream of Arklow Bridge (Ch 290-Ch 310). These, together with the elevated viewing platforms and outer walkways will enhance visual connectivity along both sides of the wall and to the river. Refer to the Landscape Design and Public Realm drawings in **Appendix 4.2.**

The increase in levels of sections of the river bank along River Walk will provide some opportunities for riparian habitat creation and refuge areas to mitigate direct and indirect effects of the river dredging works on aquatic mammals and birds.

3.5.4.3 Flood Defences – South Bank Downstream of Arklow Bridge

The Feasibility Report stage preferred option proposed reducing the pinch point in the river channel by South Quay. This would have involved widening the river channel by up to 10m with the removal of approximately 130m of the existing quay wall and the existing slipway on South Quay.

A subsequent detailed study on the hydrogeomorphology of the Avoca River along this stretch found that the widening of the channel resulted in only minor benefits in reducing deposition of sediment. In addition, in consultation with heritage specialists, public representatives and local residents, the maritime heritage and general setting value of the existing quay wall and slipway was considered to be worth preserving if possible. As such, the reduction of the pinch point was removed from the scope. The line of the flood defence wall in this area is now to run parallel to and approximately 2m behind (on the land side) of the existing quay wall to allow space for construction without impacting on the quay wall.

A 650mm high flood defence wall is proposed along the western and southern sides of the Dock. The line of the wall along the western side was reviewed in consultation with the Area Engineer and the Harbour Master in order to determine the optimum location to minimise disruption to access to the dockside while still ensuring adequate protection against flooding. Ramps over the flood defence wall are proposed together with a one-way traffic flow to allow vehicular access, including articulated trucks, to the dockside. One-way traffic is also proposed along the adjacent road.

As part of the development of the public realm and the design of the flood walls various design iterations in terms of integration of the flood walls into the riverside setting were considered. The key factors are described below in **Section 3.5.5** below. At the former Tyrells Yard, a slipway to the river is being retained respecting its heritage value (Ch 440). A permanent flood defence wall with glass panel is proposed at this location with alternative river access available in the Dock area.

The use of demountable flood gates was considered by the design team and WCC/OPW. It was considered preferable to minimise their use as the operational risk presented by such a measure was not generally acceptable. At the Dock, in the Harbour area, demountable flood barriers which will normally be maintained in a closed position will be installed in two locations: at the entrance to the boatyard and the slipway to the Dock on South Quay. It is proposed access arrangements will be agreed between WCC and the industrial and organisational stakeholders requiring access.

Access to the lifeboat station was discussed with the RNLI staff and it was agreed that a self-closing flood gate was not required at the entrance to the premises from the quay side (land side) as the access from the station to the lifeboat in the dock has to be maintained and this allows a path for flood flows. The RNLI station will therefore remain on the wet side of the flood defences..

The increase in levels of sections of the riverbank along South Bank will provide some opportunities for riparian habitat creation and refuge areas to mitigate direct and indirect effects of the river dredging works on aquatic mammals and birds.

3.5.5 Public Realm Alternatives Considered

Context

As discussed in Chapter 1 *Introduction*, in response to public consultation, the potential to enhance the public realm along the river front in conjunction with the provision of flood defence walls was considered and developed further following the feasibility report preferred option stage. In addition, engagement with Irish Water allowed a coordinated design approach between the Arklow WwTP project and Arklow FRS project. This has optimised the integration of both infrastructural projects while minimising adverse effects on the townscape and optimising amenity gain.

River Walk

River Walk is located on the river bank immediately upstream of the Arklow Bridge and parallel to Main Street in Arklow town. River Walk comprises the open river frontage, rear boundaries of properties to the south of River Walk and a small number of properties fronting onto River Walk. There is significant potential for regeneration and redevelopment of the river front properties pending the establishment of secure flood defence infrastructure. River Walk is also quite wide and includes the road carriageway, undefined parking areas, landscape zones and the river edge walkway.

Along River Walk, the required flood defence level is at its highest and the existing footpath and road levels are at their lowest. Early plans for the public realm in this area maintained the footpath level at the existing level. This resulted in a height of the flood defence wall typically c. 1.85m above footpath level, with consequent obstruction of any visual connection between River Walk and the river.

The key to developing the public realm proposals for River Walk was to ensure the connection with the Avoca River was maintained. Given the requirement for a 1.85m flood height above pedestrian level, the options available were glass walls, raised walkways or a combination of both. Glass flood defence walls that are higher than eye level have a number of disadvantages including high costs, the need for substantial steel supports and that their transparency is often reduced by staining.

The proposed public realm design considers the full width of River Walk and not just the edge along the flood defence wall. River Walk, which has limited local access vehicular traffic, will be defined as a lower-level shared surface for pedestrians and local vehicular access and a series of elevated pedestrian terraces and amenity spaces connected by a continuous promenade that extends from River Walk to the Arklow Harbour downstream.

By elevating the primary pedestrian and amenity spaces along River Walk by 450 to 700mm, the effective height of the flood defence wall is reduced to 1.15m, which permits open visibility from the pedestrian space towards the river that is unimpeded by any intervening glass panels. Where wider public terraces and seating areas are proposed, glass panels will be incorporated into the wall to increase the visual connection with the river. Additionally, the top of the flood defence wall will be chamfered such that the wall is 900mm high and sloping at 45 degrees for the top 250mm. This reduces the immediate height and provides a convenient ledge to lean against and enjoy the river.

The change in level from the lower shared surface to the elevated pedestrian area is taken up using a combination of short steps and ramps, landscaped embankments and planters, and also provides permanent seating outside the existing café and public house.

Additionally, a pedestrian ramp leads from the promenade and terraces to an elevated viewing platform that is cantilevered over the wall and river. This provides an excellent vantage point from which to enjoy the river and a second ramp leads down the outer side of the wall to the riverside walkway and continues to the floating pontoon and terrace further upstream. A second outer ramp leads up to a second elevated viewing platform directly opposite the main town carpark and will bring pedestrians back over the flood wall into the townscape.

South Quay Widening

Widening of South Quay, immediately downstream of Arklow Bridge, was largely driven by the need to install underground drainage infrastructure along South Quay while minimising disruption to residents, existing services and traffic. The solution developed was to construct a sheet piled wall parallel to and approximately 6m on the river side of the existing quay wall for approximately 280m to allow the construction of the interceptor sewer under the river bed and to backfill the sewer zone so as to widen the South Quay. This additional width, of up to 6.0m, affords greater flexibility in how the new wider South Quay is finished and utilised. A range of different design solutions were considered, informed by public realm and amenity as well as by traffic movements. The considerations included how the widened section of South Quay would best serve the town together with how it would best work in the context of the historic Arklow Bridge and the emerging proposals for River Walk and further downstream along South Quay.

Initial options included both two-way and one-way traffic links at Arklow Bridge however, the spatial requirement of a two-way solution compromised the potential pedestrian amenity of a promenade which had been flagged as a significant opportunity.

A continuous promenade from River Walk to Arklow Harbour quickly became the most beneficial solution, providing high quality amenity value for local residents and also making a significant contribution to future tourism potential of the town.

The proposal for a continuous promenade also became the driver for other design decision further downstream, with realignment of the roadway to maximise amenity value along the river edge and establishment of a series of connected riverside public spaces. The new pedestrian environment will be further enhanced by the provision of raised tables at each of the road junctions, slowing down traffic and also providing safe places to cross the road. The cross section of the new South Quay includes designated on-street parking alternately on one or both sides of the road, with some sections of potential parking given over to increased amenity space in the of grass verges and new tree planting.

South of South Green, South Quay widens substantially and the original stone quay wall with large granite kerbs stones remain intact. At this location, it is proposed to locate the new flood relief wall c. 2.m on the landward side of the original quay wall so as to retain the original wall intact and to repoint, repair and retain the large granite kerb stones in place. The promenade could have followed the road alignment with green space between it and the flood relief wall, or as is proposed, the promenade will follow the flood relief wall and river edge with green space and trees between it and the road, so as to maximise the amenity value of the promenade and respect the heritage value of the original quay. A series of six granite mooring posts, currently located in the grass verge, will be lifted and re-set along the outside of the flood relief wall and on the quay wall, respecting to their maritime heritage value.

At the former Tyrells Yard, a slipway access to the river is being retained respecting its heritage value. A permanent flood wall with glass panel is proposed at this location with alternative river access available in the harbour area. The provision of a demountable barrier was considered as an alternative at this location but it was concluded that, as an area of public realm, the operational risk presented by such a solution was not acceptable.

Arklow Bridge interface with South Quay

The southernmost arch, the first arch, of Arklow Bridge is located close to the buildings on South Quay with only a narrow quayside roadway. The challenge of introducing drainage infrastructure along the southern bank and through the first arch, together with widening the South Quay, was resolved through an iterative design process to incorporate the infrastructural requirements while maintaining the physical and visual integrity of the bridge.

Initial proposals indicated extending the South Quay wall through part of the first arch and embedding part of the arch within the new South Quay. A range of alternatives were explored to set back any widened section of quay wall from the up and downstream bridge faces. The proposed solution retains the alignment of the south bank quay wall for c. 10m and 3m upstream and downstream, respectively, of the bridge.

This section of quay wall receives the bridge and its southern piers and will be clad in a simple and contemporary polished concrete panel material that does not try to compete or blend with the bridge, but allows the historic bridge to be clearly distinguished and showcased from any later adjoining interventions. Importantly, the solution also allows the full length of the elevation of the 19 arch bridge to remain visible from both sides.

3.5.6 Biodiversity Enhancement

Dredging will take place upstream and downstream of Arklow Bridge. During the design development stage, the removal of in-river gravel beds used for birds roosting upstream of the bridge was reviewed. This review indicated that it was not possible for the overall dredge works to achieve their design objective while retaining these gravel beds. The scheme has proposed three roosting platforms upstream of Arklow Bridge to provide some alternative roosts for birds at this upstream location.

In addition, the proposed scheme will require the removal of in-river vegetated islands (to facilitate the dredging) and removal of vegetation in the Arklow marsh pNHA (to facilitate the embankment construction). During the design development stage, the removal of these habitats was reviewed. The review indicated that it was not possible for the scheme to achieve its design objective whilst retaining the vegetated islands in the river and the vegetation in the marsh. The scheme has proposed landscaping at Arklow Marsh (on the dry side of the embankment), on the north river bank upstream of the bridge and an extension to the north river bank further upstream. This will provide some opportunities for habitat creation and mitigation of direct and indirect effects on biodiversity due to the loss of the in-river vegetated islands and loss of habitat in the marsh.

The increase in levels of sections of the river bank along River Walk and South Quay will provide some opportunities for riparian habitat creation and refuge areas to mitigate direct and indirect effects of the river dredging works on aquatic mammals and birds.

Bat boxes and bat tubes will be permanently installed in the arches of Arklow Bridge (upstream side), in the flood walls and in the RC columns of the debris trap to mitigate direct and indirect effects on bats due to the construction works at Arklow Bridge.

Nesting boxes for birds will be installed under the deck of Arklow Bridge to provide an improved environmental for birdlife.

3.6 Methods of Construction – Alternatives Considered

3.6.1 Underpinning of Arklow Bridge

A number of different methodologies were considered for the underpinning of Arklow Bridge. These are:

- Traditional underpinning of piers and abutments
- Micro-piling of piers and abutments from riverbed level
- Mini-piling of piers and abutments from bridge deck level
- Reinforced concrete (RC) containment wall around piers and abutment

All of the above options would require grouting of the bridge superstructure and formation to varying degrees in order to strengthen the bridge superstructure, improve the bearing capacity at the formation level of the underpinning, stabilise the sides of excavations and control ground water. Various factors influence the selection of the preferred method of construction including:

- Material within bridge structure – this influences the volume and extent of the proposed grouting and the resultant strengthening of the bridge.
- Soils in bridge formation - this influences the volume and extent of the proposed grouting at formation level and the resultant bearing capacity of the formation and control of water ingress through the riverbed materials.
- Contractor expertise – contractors will have their own preferences for underpinning based on their historical experience and available equipment, especially piling and micro-piling rigs.
- Speed of construction – works at bridge deck level will impact on traffic crossing the bridge while works at riverbed level will be restricted by the seasonal nature of the work. Hence, the speed of the different construction methods will be factors in their selection by contractors.
- Traffic impact – working on the bridge deck will impact on vehicular traffic crossing the bridge. Grouting from the bridge deck can be carried out with traffic control limiting traffic to a single lane in a shuttle (stop/go) system. In consultation with the local Roads Department, it was considered that traffic disruption would still be unacceptable if the work was to be carried out during daytime. As such, night-time working (19:00 to 7:00) would be required for the grouting works.
- Similarly, mini-piling from the bridge deck can be carried out with traffic control limiting traffic to a single lane in a shuttle (stop/go) system. Night-time working (19:00 to 7:00) would be required for these piling works.

As selection of the preferred underpinning methodology will be the subject to the detailed consideration by the contractor, as described above, this EIAR has included a description of all these underpinning options in **Section 5.5.1.5** of **Chapter 5,** *Construction Strategy*. All these underpinning approaches have been considered in the assessment of construction effects in the specialist chapters.

3.6.2 The selection of the construction methodology for the proposed flood defence walls

The selection of the construction methodology for the proposed flood defence walls will largely be determined by the appointed Contractor, depending on the relative costs of construction at the time of contract award, the Contractor's own areas of expertise and the Contractor's approach to the risks associated with each type of construction. However, it is envisaged that the flood defence walls to be located on the river side of the existing quay walls and riverbank and in areas of soft ground on the north bank will be founded on sheet piles driven from ground level to the required depth and other flood defence walls will be founded on traditional reinforced concrete bases.

3.6.3 Dredging Works

Dredging will take place upstream and downstream of Arklow Bridge. A dredge material management study was undertaken to consider various dredge material management options. The preferred options for the material management were identified. The study considered the characteristics of the dredge material and the following alternatives for their management:

- Material reuse
- Soil recovery
- Disposal on land
- Disposal at Sea

In accordance with the waste hierarchy defined under the EU Waste Framework Directive, disposal at sea is only to be considered if material cannot be reused, recycled or recovered. As the most of the dredge material is suitable for reuse, recovery or delivery to inert waste facilities, disposal at sea was not progressed as part of this scheme.

As described in **Chapter 15**, *Resource and Waste Management*, the management of dredge material will follow the waste hierarchy. A portion will be reused within the scheme at the Arklow Town Marsh embankment. A portion will be reused offsite where possible. Material which cannot be reused on of offsite, will be disposed of in a suitable licensed waste facility.

Dredging can be carried out by a number of methods including a suction dredger, a dragline, a mechanical excavator operating from a jack-up (spud) barge or a mechanical excavator operation from temporary haul roads within the river channel. The dredged material can be transported from the river by barge or by dump trucks using temporary haul roads within the river channel.

It is considered that suction dredging will not be a viable option due to the shallow depth, especially along the edges of the channel, the relatively small tidal range and the relative cost of this option considering the volume of material to be dredged.

The other options mentioned above are considered to be viable options and one or more could be selected by the contractor to carry out the work.

3.7 References

BLP (2013) Avoca River (Arklow) Flood Relief Feasibility Study (September 2013)

BLP (2015) Avoca River (Arklow) Flood Relief Feasibility Study Hydraulic Modelling Options Report (June 2015)

BLP (2016) Avoca River (Arklow) Flood Relief Feasibility Study Report on Options Screening Workshop (August 2016)

BLP (2017) Avoca River (Arklow) Flood Relief Scheme – Feasibility Study Report (July 2017)

EPA (2017) Draft Guidelines on the Information to be contained in Environmental Impact Assessment Reports (EPA, Draft August 2017)

GDG (2019) Arklow Flood Relief Scheme – Hydrogeomorphology Study – Hydraulic modelling of the Avoca River

OPW (2013) Guidance Note No 28 - Option Appraisal and Multi Criteria Analysis (MCA) Framework University of Bradford (2010) Arklow Bridge – Assessment of Scour Potential

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