Galway Harbour Company

Galway Harbour Extension

Appendices to NIS Addendum / Errata

Appendix No. 3.1 – Potential Impacts and Mitigation

[From Chapter 7 of the EIS – Pages 7-121 to 7-142]

1 IMPACTS ON TERRESTRIAL COMMUNITIES

1.1 IMPACTS ON TERRESTRIAL COMMUNITIES DURING THE CONSTRUCTION PHASE – HABITAT LOSS PERMANENT SLIGHT POSITIVE IMPACT

The terrestrial part of the site of the proposed development is small (less than 10%) in comparison to the development area as a whole. Most of the redevelopment of the harbour enterprise park will involve works on existing roads, or will affect areas covered by habitats that are not of importance (*e.g.* spoil and bare ground or recolonising bare ground). An area of 0.29 ha of scrub (not an annexed habitat) will be lost on the existing railway embankment in the making of the proposed rail connection.

Mitigation: Loss of terrestrial habitats will be mitigated through the proposed planting plan and landscaping scheme which incorporates a planting of native planting of 5.44 ha. The residual associated impact is therefore considered a permanent slight positive impact.

2 IMPACTS ON MARINE COMMUNITIES

2.1 IMPACTS ON MARINE COMMUNITIES DURING THE CONSTRUCTION PHASE – HABITAT LOSS PERMANENT SIGNIFICANT NEGATIVE IMPACT

Approximately 0.16% of the cSAC/SPA marine habitat will be lost through the construction of the harbour extension. It is comprised of mud/sandflats and reef habitat described by the NPWS as a “fucoid-dominated reef community complex.” The quality of these habitats in that section of Galway Bay are poor due to a long history of organic enrichment, fluctuating salinities, resuspension due to storms and maintenance dredging. Reclamation of land as part of the construction of the proposed development constitutes a direct and irreplaceable loss of 29.79 ha of habitat for marine plants and invertebrates of which 5.93 ha is represented by the fucoid-dominated reef community complex which is a qualifying interest habitat for the cSAC.

Mitigation: It is not possible to mitigate for the loss of subtidal habitat. Loss of intertidal habitat will be mitigated for by the construction of new quay wall and rock armouring (see below).

2.2 IMPACTS ON MARINE COMMUNITIES DURING THE CONSTRUCTION PHASE – HABITAT CREATION *PERMANENT MODERATE POSITIVE IMPACT*

Approximately 76,000 m^2 quay wall and break water will be created as part of this project. Recent research (Firth *et al.,* 2010) on textured and engineered *e.g.* the introduction of pits, crevasses, holes *etc*, cement blocks for use in coastal protection in the U.K. has shown that this gives rise to greatly increased rates of settlement of both flora and fauna. This will more than compensate for the 550 m of current man-made rock wall coastline that will be covered.

Mitigation: None required.

2.3 IMPACTS ON MARINE COMMUNITIES DURING THE CONSTRUCTION PHASE – HABITAT LOSS OF DREDGE AREA

Short-term Moderate Negative Impact

Initial dredging of the approach channel and turning areas will cause the loss of bottom-dwelling in fauna, making them temporarily unsuitable for bottom feeding fish. The proposed dredge area is 46.48 ha. This is a temporary impact as recolonisation will commence immediately postdredge. The original community and biomass will re-establish after *ca 2 years*. Dredged areas will experience sediment import from the River Corrib flow and will require periodic *(ca* every 10 years) maintenance dredging.

Mitigation: None possible.

2.4 IMPACTS ON MARINE COMMUNITIES DURING THE CONSTRUCTION PHASE – PHYSICAL DAMAGE OF DESTRUCTION CAUSED BY UNDERWATER BLASTING

Temporary Potentially Moderate Negative Impact
The detonation of explosives under the sea generates a percussive shock wave that passes through the water, often travelling for great distances. The thermal and explosive effects of a sub-surface detonation are limited to the immediate vicinity of the explosion and the shock wave is the primary cause of damage to aquatic life. When blasting is carried out to remove rock, the explosives are detonated in boreholes within (and not at the surface of) the rock. The potential impacts on marine animals include direct physical damage (*e.g.* internal injury auditory damage/deafness in fish and marine mammals), indirect physical damage (*e.g.* sound-induced formation of bubbles that could cause 'the bends' in deep-diving species), perceptual impacts (*e.g.* the interference of the blasting sound with echolocation or intra-species communication), behavioural impacts (*e.g.* avoidance of the blast area), stress (*e.g.* induction of physiological effects such as increased heart and respiratory rates) and indirect effects *(e.g.* the reduction of prey availability) (Gordon *et al*., 1998).

Mitigation: None possible.

2.5 IMPACTS ON MARINE COMMUNITIES DURING THE CONSTRUCTION PHASE – PHYSICAL DAMAGE OF DESTRUCTION CAUSED BY PILE DRIVING

Permanent |Moderate Negative Impact
Fish are sensitive to noise and vibration and construction activities could cause avoidance reactions and possibly delay fish migration. Nedwell (cited in Solomon, 2001, p. 32) suggested that an avoidance reaction may be induced at distances of up to 2 km from pile driving works. Driven sheet piles are a component of the construction of the proposed development. The piles would be secured into bedrock that had previously been drilled and blasted. Investigations into the noise produced by oil drilling platforms has shown that drilling can produce infrasound at approximately 5 Hz at levels in the range 119-127 dB at distances from 9 to 61 metres from the drilling rig (Vella *et al*., 2001), within the range of the sound sensitivity of salmon (Hawkins and Johnstone, 1978), so there may be some localised effect on migrating Salmon. It should also be stated that the drilling and blasting required for the placing of sheet piles for the proposed development would be a short-term operation and that any environmental impacts caused by drilling noise would also be short-term, therefore.

Mitigation: None possible.

2.6 IMPACTS ON MARINE COMMUNITIES DURING THE CONSTRUCTION PHASE – PHYSICAL DAMAGE OF DESTRUCTION CAUSED BY THE NOISE OF DREDGING

Temporary Slight Negative Impact

Dredging can be characterized as a continuous, tonal, low frequency noise source. Richardson *et al*. (1995) recorded peak noise levels of 178 dB at 160 Hz, with an overall source level of 185 dB during dredging operations. There are various types of equipment used for marine dredging. Capital dredging is often carried out using back hoe rock dredgers. Dredging of sediments can be achieved with grab or clamshell dredges (these lift bucketfuls of silt onto waiting barges), with hopper dredges (these ships pass over the dredge site sucking sediments into an internal hopper via trailing dragheads), or with transfer dredges (moored or anchored ships which transfer sediments onshore or into barges via a suction pipe). It is proposed that 1,815,000 cubic metres of soft sediment will be dredged-up using a cutter suction dredger as part of the proposed development. It is estimated that this work will take 18 weeks to complete. In some of the areas where a greater depth is required some rock will have to be removed. This will be achieved by blasting, followed by the removal of the blasted rock with a back hoe dredger.

Richardson *et al*. (1995) noted that two different vessels operating as transfer dredges produced different sound levels, but that the noisiest of these was at most only as noisy as the quietest of the hopper dredger whose noise levels were also checked. Westerberg (1982), while acoustically tracking adult salmon moving through coastal waters in the Baltic, found that they passed within 100-150 m of working dredgers without hesitation. At ranges of less than 100 metres form the dredging, contact with the ultrasonic transmitter was lost due to the intense background dredge noise, but the Salmon passed without any appreciable delay and “seemed essentially unaffected by the dredging at even closer range”. A number of Dutch bucket-dredgers were working sand and gravel in the area; no measurements were made of the dredging sound (Dr. Håkan Westerberg, Fiskeriversket, National Board of Fisheries, Sweden, pers comm.).

Using available information and current suggested best practice (Southall *et al*., 2007) it has been calculated that the impact threshold distances for physical damage caused by dredging (worst case scenario for backhoe dredging) at the site are up to 128 metres for fish (based on an unlikely 24 hour exposure at that distance). The impact threshold distances for disturbance caused by dredging at the site are up to 32 metres for fish (based on a 5 minute exposure at that distance).

Mitigation: None possible.

2.7 IMPACTS ON MARINE COMMUNITIES DURING THE CONSTRUCTION PHASE – ADVERSE IMPACTS CAUSED BY SHIPPING

Permanent Neutral or Imperceptible Negative Impact

The hearing of salmon is restricted to frequencies below approximately 380 Hz and hearing sensitivity drops off steeply above 150 Hz (Hawkins and Johnstone, 1978). Knudsen *et al*. (1992, 1994) observed strong avoidance reactions from salmon smolts in response to underwater noise. These reactions were to low frequency noises at 10 kHz, while minimal reactions were shown to higher frequency noises at 150 kHz. These workers conducted experiments using pure sine waves, rather than more complex noises like boat noise.

However, Nedwell (cited in Solomon, 2001, p. 31) presented data showing that the noises produced by ships are low frequency (below 50 kHz), in the range with greatest behavioural impact for salmon. Moore and Ives (cited in Solomon, 2001, p. 31) detailed evidence of salmon smolts swimming away from boat sound in Southampton Water, UK. No dredging was taking place when the observations were made. These observations contradict those made by

Westerberg on adult salmon (see above) and it is possible that adults are less affected by noise than are smolts. Assuming that the development of a deep water dock would lead to the increased usage of Galway Harbour by shipping, any current impact on migrating smolts could be increased as a result. However, the range over which such responses can be caused would have a bearing on the possible impacts of shipping noise; the new deep water dock would have the effect of moving large ships further from the mouth of the River Corrib.

Given that there is currently low frequency noise from large ships entering the harbour, that these are relatively localized to the vicinity of the actual individual vessel and that their duration in any particular area is short, coupled with the fact that large vessels will be moved further from the area of the river mouth as a result of the proposed development, significant negative impacts are not envisaged.

Mitigation: None possible.

2.8 IMPACTS ON MARINE COMMUNITIES DURING THE CONSTRUCTION PHASE – ADVERSE IMPACTS CAUSED BY SUSPENDED SOLIDS/SEDIMENT

Temporary Moderate Negative Impact

Dredging and water-based construction activity will cause an increase of suspended solids in the operation area. The suction head of the Trailer Suction Hopper Dredger will be immersed in the sediments which will minimise silt suspension. The softer materials will not be dredged using a backhoe as this would result in a greater loss of fines. The stiffer materials will be lifted in a closed backhoe bucket to minimise the loss of finer material. Placing the dredged materials in custom-built lagoons will result in water being displaced from the lagoons and from the saturated soils. The sediments are not contaminated and the discharged water will be filtered by a membrane lining of the lagoon walls. Chapter 4 of the EIS details this proposed lagoon wall.

The reduction in quality of water through increased suspended solids poses a risk to fish and mammals and infaunal communities within the zone of influence, which have the potential for secondary impact of reduced food availability for birds, mammals and other fish species.

The turbidity caused by suspended solids can affect primary production by shading and increased sedimentation can disturb benthic communities. Newcombe and MacDonald (1991) state that high levels of suspended solids (typically of the order of 20,000 mg/L or more for exposure periods of 24 to 96 hours for smolts of several species) can be lethal for salmonoids. The same authors also detail sub-lethal responses (including cellular damage and physiological stress) and behavioural responses (*e.g.* avoidance behaviour and alarm responses) to suspended solids.

The concentrations of suspended solids causing these responses were variable (from 6 to 650 mg/l for behavioural responses and from 14 to 1547 mg/l for sub-lethal responses) and are probably dependent on the duration of exposure of the fish to the suspended solids. Whitman *et al.* (1992) observed the effects on Pacific Chinook Salmon (*Oncorhynchus tshawytscha*) that were caused when volcanic ash was added to water under experimental conditions.

When ash was added to a concentration of 350 mg/l the preference of the fish for home water (*i.e.* water from their natal river) was significantly reduced. This was apparently due to avoidance of the ash, rather than an inability to identify home water. The proposed limit recommended is 50 mg/l above background levels measured 100m distance down current of the dredge vessel.

The adverse impacts of suspended solids on fish that have been recorded experimentally are generally at concentrations greater than 10 mg/l and often several orders of magnitude more than this. Results from the capital dredge sediment analysis (see Chapter 8 of EIS) predict that concentrations of suspended material in the dredge plume will fall to concentrations of 5 mg/l or less within several hundred metres of the dredge site. It should be realized that negative impacts on fish from experimental data often followed prolonged periods of exposure, whereas fish in the vicinity of the site of the proposed development will have the opportunity to move away from areas affected by the dredge plume.

In addition, the material that will be removed after dredging and blasting (*i.e*. 1,815,000 cubic metres of wet silt and muddy material and 24,000 cubic metres of rock) will all be used as fill material for the land reclamation portion of the proposed development, so there will be no impact from the disposal at sea of construction dredge spoil.

Dredging and other construction activity will cause the level of suspended solids in the area to be temporarily increased. There is also a possibility that the placement of the wet dredged sediment that will be used to partially fill the reclaimed land section of the development will give rise to a runoff of seawater. This runoff will be controlled to ensure that the carry back of fine sediment will be less than the limits.

The turbidity caused by suspended solids will locally affect primary production by shading and smothering of benthic communities. In Chapter 8 of the EIS, the model predications indicate that this smothering will be localised to around *ca* 50 m of the dredging operations. The model predicts that at sites close to the mouth of Lough Atalia, sediments suspended by the dredging operation will enter the lough

Mitigation: It is not possible to mitigate against smothering of benthic communities around the dredger. In order to prevent suspended sediments entering Lough Atalia, dredging activity will be restricted to periods of ebb tide in the vicinity of the entrance to the lough.

The design of the proposed development includes the use of geotextiles to line the filled area and also incorporates the continuous gradual filtered release of dredged transport water. This will reduce or remove the possibility of silt escaping back into the marine environment from the development. The geotextile mesh will be sized to retain suspended solids in the land reclamation lagoons.

2.9 IMPACTS ON MARINE COMMUNITIES AS A RESULT OF POTENTIAL FOR SPILLAGES DURING CONSTRUCTION

Short-term Potentially Significant Impact
Pollution from accidental spillages of fuel or oil from construction machinery may occur if the environmental management plan is not adhered to.

Mitigation: All machinery used in the construction of the proposed development will be checked to ensure that it is well maintained and not likely to leak fuel, lubricating oils, greases etc. into the aquatic environment. Any onsite refueling or maintenance will be carried out on a securely-bunded temporary hard stand areas. All oily wastes generated will be stored in leak-proofs tanks for removal by a licensed operator holding a valid Waste Collection Permit. Detailed construction and waste management plans will be agreed and put in place prior to the start of works. Dredgers will be re-fuelled in the existing docks using best available practice to ensure no spillages into the designated sites.

2.10 IMPACTS ON MARINE COMMUNITIES AS A RESULT OF USE OF CONCRETE DURING CONSTRUCTION

Short-term Potentially Significant Negative Impact (localised)

Uncured (wet) concrete will only be used to grout mass pre-cast concrete blocks. Uncured concrete in direct contact with water is toxic to aquatic life.

Mitigation: Normal best construction practice with regard to the use of concrete will be adhered to. Pre-cast concrete elements will be used wherever possible. Any wash water contaminated with concrete will not be allowed to enter the marine environment and will be disposed of elsewhere. Contaminated equipment (e.g. concrete delivery trucks, pumping equipment and tools) will be cleaned where there is no possibility of the drainage of wash water to the marine environment. The design by using sheet pile and rock armour has ensured a minimal underwater concrete requirement. There will be concrete quay etc. and these will be above tide level. Chapter 4 of the EIS details the proposed construction methods.

2.11 IMPACTS ON MARINE COMMUNITIES DURING OPERATION PHASE CAUSED BY CHANGED RIVER FLOW AND SEDIMENT EXPORT

Short-term Slightly Negative Impact (localised)

The narrowing of the river mouth that will result from the construction of the proposed development means that the flow rate of the river will increase in this area. The predicted impact on flow is the deflection of the Corrib outflow more southwards towards Mutton Island resulting in a concentration of flow along the proposed dredged channel past the marina breakwater (see Chapter 8). Simulations indicate higher velocities *i.e.* increasing from 0.1–0.15 m/s to 0.2 - .25 m/s will occur. This in turn will cause short-term remobilisation of sediment form this area to the south

The results of modelling indicate that the proposed development restricts the erosive flow to the proposed dredge channel immediately to its west. This may have the beneficial effect of reducing the dredging maintenance requirement (currently approximately 50 centimetres of silt is removed at roughly ten year intervals). The overall conclusion from the modelling is that the proposed port configuration will confine the high flows and critical bed shear to the approach channels and will not result in any erosive impact elsewhere.

Simulation of the fine sediment from the River Corrib showed the proposed development extending the river plume (and thus suspended sediment) southwards out to sea past Mutton Island on the ebbing tide and away from the Renmore area. On the flooding tide the plume is much more diluted.

The simulation results indicate a reduction of between 40 and 60% in fine sediment load east of the proposed development

Mitigation: None possible

2.12 IMPACTS ON MARINE COMMUNITIES DURING OPERATION PHASE DUE TO CHANGES IN SALINITY REGIME

Permanent Slight Positive Impact

The impact of the proposed new structure will increase salinities immediately to the east of it under average River Corrib flows. This impact will be reflected under Corrib flood flow conditions and to a lesser extent under low flow conditions. Reductions in salinity are predicted to the west of the structure and very minor changes are predicted for Lough Atalia and the waters beyond Mutton Island.

As a consequence of the proposed development, the Corrib plume will flow directly southwards and south southwest towards Mutton Island and thus more out to sea than at present, with no opportunity for the freshwater plume to directly disperse into the Renmore Bay area. On neap tides, the predicted changes will be east of the new port, with average increases in salinity of 2.2 to 4.8 psu (practical salinity units) and very minor changes elsewhere, including Lough Atalia. To the west of the structure, salinities will be depressed on neap tides and spate river conditions at low water. On spring tides, salinities will increase in the Renmore shoreline area, with increased salinities to 7.2 psu and 8.5 psu respectively. In Lough Atalia, a slight reduction in median salinity concentrations is predicted. Further south along the new approach channel reductions in salinity are also predicted.

Since migrating salmon are attracted by scent to their natal waters, given that there will be more freshwater flowing between the causeway and the new structure salmon will more easily find the mouth of the Corrib. It is known that presently some salmon initially enter Lough Atalia before swimming upstream to Lough Corrib. This will continue to occur.

Mitigation: None possible

2.13 IMPACTS ON MARINE COMMUNITIES DURING OPERATION PHASE DUE TO POLLUTION ASSOCIATED WITH WASTEWATER FROM OPERATIONS

No impact

Since all foul sewage generated within the area of the proposed development will be piped to the existing pumping station (which has sufficient capacity for both the existing and the proposed developments) and then pumped into the Galway City main drainage network for treatment, the wastewater produced as a result of the proposed development will not have an impact.

Mitigation: None required

2.14 IMPACTS ON MARINE COMMUNITIES DURING OPERATION PHASE DUE TO SUSPENDED SOLIDS FROM RECLAIMED LAND

Potential Serial Short-term Moderate Negative Impact Events

Fill material used to create the reclaimed land creates the potential for increased suspended solids to runoff and affect water quality.

Mitigation: The design of the proposed development includes the use of geotextiles to line the filled area and also incorporates the continuous gradual filtered release of dredged transport water. This will reduce or remove the possibility of silt escaping back into the marine environment from the development.

2.15 IMPACTS ON MARINE COMMUNITIES DURING OPERATION PHASE DUE TO REGULAR MAINTENANCE DREDGING

Short-term Serial Localised Moderate Negative Impacts (similar to those that already occur)

Maintenance dredging, which takes place along the existing dock every ten years or so, would also be a periodic necessity for the proposed development. Maintenance dredging brings with it the impacts that would come from dredging and spoil disposal (*i.e.* temporary loss of infaunal communities and fish feeding areas, increased suspended solids loads, decreased dissolved oxygen levels, mobilisation of any toxic compounds in the silt).

Before the harbour channel was last dredged (in August 2001), it was calculated that 80,000 m^3 of dredging spoil would be disposed of. Modelling work suggested that, after dumping, the thickness of settled material would drop to less than 1 mm within a radius of 450 metres from the edge of the dumping site. The same modelling work predicted that “resuspension rates were of a very low order and, therefore, the volume of material being resuspended is small enough to be deemed insignificant” (Aquafact report, 2001). The effects of the settling and possible resuspension of dredging spoil dumped as part of the maintenance works for the proposed development would be dependent on the amount of material dumped.

Mitigation: Spoil from maintenance dredging will be disposed of to a permitted site located outside Natura 2000 sites.

2.16 IMPACTS ON MARINE COMMUNITIES DURING OPERATION PHASE DUE TO POTENTIAL FOR INCREASED SUSPENSION OF BOTTOM SEDIMENT CAUSED BY INCREASED SHIP TRAFFIC

Permanent Slight Positive Impact

Vessels approaching the docks may cause the local suspension/re-suspension of some sediment from the sea bed. However, the greater depth (8 to 10 metres, compared with 3.4 metres in the current dredged channel) of water at the proposed new berths indicates that this effect will reduce rather than increase.

Mitigation: None required.

2.17 IMPACTS ON MARINE COMMUNITIES DURING OPERATION PHASE DUE TO INCREASED POTENTIAL FOR INCREASED POLLUTION FROM SHIPPING

Potential Serial Short-term and Long-term Significant Negative Impacts

There is a potential risk of hydrocarbon pollution from accidental spillages/ bilge flushing *etc*. from shipping. These compounds tend to accumulate in receiving environments because of their very persistent nature. The Sea Pollution (Miscellaneous Provisions) Bill, in enacting the International Convention on the Control of Harmful Antifouling Systems for Ships, made the reapplication of TBT paints to ships illegal at the beginning of the year 2003. The effect of this should be a gradual reduction in TBT levels in the environment. Galway Harbour Company’s Environmental Management Plan deals with the requirements on shipping to ensure no spillages to the water (See Appendix 4.2).

Mitigation: A detailed spill response plan has been prepared (Oil Spill Contingency Plan Appendix 4.3). This will limit the negative effects of any spills. GHC have an Environmental Management policy to ensure that there are no spillages to the sea.

2.18 IMPACTS ON MARINE SPECIES DURING OPERATIONAL PHASE DUE TO INCREASED POTENTIAL FOR RISK OF INTRODUCTION OF INVASIVE ALIEN SPECIES BY SHIPPING

Potential Permanent Significant Negative Impact
Transnational shipping leads to an increased risk of the introduction of potentially harmful alien species into Galway Bay.

Mitigation: Harbour Company will implement the Environmental Management Plan and policy regarding handling of invasive alien species.

3 IMPACTS ON LOUGH ATALIA/ZONE OF POTENTIAL INFLUENCE

By adopting the recommended mitigation measures and adopting the environmental management plan, no additional suspended sediments will enter Lough Atalia and Renmore Lagoon and their sedimentary characteristics will not alter. The model predicts a possible decrease in salinity of 1.8 psu within Lough Atalia. Given the measured range of 1 – 29 S_P, it is not considered that such a potential increase will have any effect on the ecological functioning of this water body. The model predicts that salinities to the east of the new structure may increase.

Since there will be no perceptible change in tidal range or erosion/deposition regimes as a result of the construction of the proposed development and no significant change to the salinity regime in Lough Atalia, terrestrial habitats outside of the site red line area will not be impacted negatively as a result of the proposed development.

4 IMPACTS ON FISH

4.1 IMPACTS ON FISH DURING THE CONSTRUCTION PHASE – SUBTIDAL HABITAT LOSS

Permanent Moderate Negative Impact
Reclamation of land as part of the construction of the proposed development constitutes the direct and irreplaceable loss of 26.93 ha of potential feeding habitat for fish, sea birds and sea mammals. This removal of marine habitat also constitutes a small part of the fishing grounds for Shrimp. Since the reclaimed land is intended for industrial use, it is likely that the terrestrial area created will have little, if any, ecological value.

Mitigation: None possible.

4.2 IMPACTS ON FISH DURING THE CONSTRUCTION PHASE – INTERTIDAL HABITAT LOSS

Permanent Slight Negative Impact
Approximately 5.93 ha of foreshore between Rinmore Point and Renmore beach will be lost when the development is constructed. This is an area with boulders interspersed with muddy sand and shell fragments, with patches of brown algae. This constitutes an area of potential shelter for small fish and a feeding area at high tide. In the context of the Galway Bay complex cSAC, this constitutes 0.2% of the total available foreshore (calculated at 2,555 ha).

Mitigation: None possible.

4.3 IMPACTS ON FISH DURING THE CONSTRUCTION PHASE - HABITAT CREATION

Permanent Moderate Positive Impact
Approximately 1,400 m of rocky (rock wall) coastline (equivalent to one hectare of intertidal zone) will be created on the eastern side of the land reclamation site. This will more than compensate for the 550 m of current man-made rock wall coastline that will be destroyed during the land reclamation procedure. These rock walls constitute habitat for the epifauna and flora typical of sheltered rocky shores. In addition there will be approximately 1,000 m of quay wall (consisting of concrete and concrete piles) and approximately 1,700 m of dock and causeway built. Recent research (Firth *et al.,* 2010) on textured and engineered *e.g.* the introduction of pits, crevasses, holes *etc*, cement blocks for use in coastal protection in the U.K. has shown that this gives rise to greatly increased rates of settlement of both flora and fauna. These structures will quickly become covered with the same type of community and will also form extra cover and feeding areas for associated fish species.

Mitigation: None necessary.

4.4 IMPACTS ON FISH DURING CONSTRUCTION PHASE - HABITAT LOSS OF DREDGE AREA

Short-term Moderate Negative Impact
Initial dredging will cause the loss of bottom-dwelling infauna from the dredged areas, making them unsuitable for bottom-feeding fish. The proposed dredge area is 46.5 ha. This is a temporary impact: it would take several months for recolonisation to occur and several years for the original community and biomass to be re-established. Dredged areas would, of course, be subject to sediment export caused by the River Corrib flow and to periodic maintenance dredging.

Mitigation: None possible.

4.5 IMPACTS ON FISH DURING CONSTRUCTION PHASE - PHYSICAL DAMAGE OR DISTURBANCE CAUSED BY UNDERWATER DRILLING AND BLASTING

Temporary Potentially Moderate Negative Impact
The detonation of explosives under the sea generates a percussive shock wave that passes through the water, often travelling for great distances. The thermal and explosive effects of a sub-surface detonation are limited to the immediate vicinity of the explosion and the shock wave is the primary cause of damage to aquatic life. When blasting is carried out to remove rock, the explosives are detonated in boreholes within (and not at the surface of) the rock. The potential impacts on marine animals include direct physical damage (*e.g.* internal injury auditory damage/deafness in fish and marine mammals), indirect physical damage (*e.g.* sound-induced formation of bubbles that could cause ‘the bends’ in deep-diving species), perceptual impacts (*e.g.* the interference of the blasting sound with echolocation or intra-species communication), behavioural impacts (*e.g.* avoidance of the blast area), stress (*e.g.* induction of physiological effects such as increased heart and respiratory rates) and indirect effects (*e.g.* the reduction of prey availability) (Gordon *et al*., 1998).

Mitigation: In order to minimise the effects of the construction phase on migrating Atlantic Salmon and other anadromous species, blasting and piling will be limited to periods when juvenile stage salmonids are not passing in the vicinity of the proposed development. Work will be completed between 1st August and 31st March inclusive to eliminate the impact of these activities by avoiding April to July downriver run of smolts. This proposed timing of works would also avoid most of the upstream spawning migration of Sea Lamprey. Additionally, European Eel, while not an Annex II species and therefore not a Qualifying Interest for either cSAC, which also migrates through the area at this time will not be impacted by blasting.

Explosion weight will be limited to a maximum of 10kg.

Blasting and drilling work will not be undertaken during the night, thus limiting the effects of noise on the movements of populations of migratory fish in the area *i.e.* they will be able to migrate undisturbed during non-blasting hours.

Underwater noise levels will be monitored prior to commencement of development, with particular emphasis on the presence of seals and during the smolt and eel migration period.

4.6 IMPACTS ON FISH DURING CONSTRUCTION PHASE - PHYSICAL DAMAGE OR DISTURBANCE CAUSED BY PILE DRIVING

Temporary Slight Negative Impact

Fish are sensitive to noise and vibration and construction activities could cause avoidance reactions and possibly delay fish migration. Nedwell (cited in Solomon, 2001, p. 32) suggested that an avoidance reaction may be induced at distances of up to 2 km from pile driving works. Driven sheet piles are a component of the construction of the proposed development. The piles would be secured into bedrock that had previously been drilled and blasted. Investigations into the noise produced by oil drilling platforms has shown that drilling can produce infrasound at approximately 5 Hz at levels in the range 119-127 dB at distances from 9 to 61 m from the drilling rig (Vella *et al*., 2001), within the range of the sound sensitivity of Salmon (Hawkins and Johnstone, 1978), so there may be some localised effect on migrating Salmon. Avoidance to infrasounds at 11.8 Hz has been demonstrated in migrating silver Eel (Sand *et al*., cited in Vella *et al*., 2001, p. 52), although this would not be significant if there were no works during the night when Eel are migrating. It should also be stated that the drilling and blasting required for the placing of sheet piles for the proposed development would be a short-term operation and that any environmental impacts caused by drilling noise would also be short-term, therefore.

Mitigation: In order to minimise the effects of the construction phase on migrating Atlantic Salmon, piling will be limited to periods when juvenile stage salmonids are not passing in the vicinity of the proposed development. Work will be completed between 1st August and 31st March inclusive to eliminate the impact of these activities by avoiding April to July downriver run of smolts. This proposed timing of works would also avoid most of the upstream spawning migration of Sea Lamprey. Additionally, European Eel, while not an Annex II species and therefore not a Qualifying Interest for either cSAC, which also migrates through the area at this time will not be impacted by pile driving.

Pile driving will not be undertaken during the night, thus limiting the effects of noise on the movements of populations of migratory fish in the area *i.e.* they will be able to migrate undisturbed for a minimum of 8 hours during night-time hours.

Underwater noise levels will be monitored prior to commencement of development, with particular emphasis on the presence of seals and during the smolt and eel migration period.

4.7 IMPACTS ON FISH DURING CONSTRUCTION PHASE - PHYSICAL DAMAGE OR DISTURBANCE CAUSED BY DREDGING

Temporary Slight Negative Impact

Dredging can be characterized as a continuous, tonal, low frequency noise source. Richardson *et al*. (1995) recorded peak noise levels of 178 dB at 160 Hz, with an overall source level of 185 dB during dredging operations. There are various types of equipment used for marine dredging. Capital dredging is often carried out using back hoe rock dredgers. Dredging of sediments can be achieved with backhoe (these lift bucketfuls of silt onto waiting barges), with hopper dredges (these ships pass over the dredge site sucking sediments into an internal hopper via trailing dragheads), or with transfer dredges (moored or anchored ships which transfer sediments onshore or into barges via a suction pipe). It is proposed that 1.815 million cubic metres of soft sediment will be dredged-up using (i) a Trailer suction hopper dredger dredging the upper softer layers into a floating pipeline and (ii) a backhoe excavator on a raft dredging the stiffer lower layers into a barge. It is estimated that this work will be broken into more than one season each of approx 36 weeks. In part of the main berthing area where a greater depth is required some rock will have to be removed. This will be achieved by blasting, followed by the removal of the blasted rock with a back hoe dredger.

Likewise some rock will be required to be removed to key in sheet piles. Total rock removal is estimated as 24000 cubic metres or 1.3% of the dredging. 98.7 % of the dredging will be of the lower noise generating sediment dredging.

Richardson *et al*. (1995) noted that two different vessels operating as transfer dredgers produced different sound levels, but that the noisiest of these was at most only as noisy as the quietest of the hopper dredgers whose noise levels were also checked. Westerberg (1982), while acoustically tracking adult salmon moving through coastal waters in the Baltic, found that they passed within 100-150 m of working dredgers without hesitation. At ranges of less than 100 metres from the dredging, contact with the ultrasonic transmitter was lost due to the intense background dredge noise, but the Salmon passed without any appreciable delay and “seemed essentially unaffected by the dredging at even closer range”.

Using available information and current suggested best practice (Southall *et al*., 2007) it has been calculated (see Chapter 10, Noise and Vibration) that the impact threshold distances for physical damage caused by dredging (worst case scenario for backhoe dredging) at the site are up to 128 metres for fish (based on an unlikely 24 hour exposure at that distance). The impact threshold distances for disturbance caused by dredging at the site are up to 32 metres for fish (based on a 5 minute exposure at that distance).

Mitigation: In order to minimise the effects of the construction phase on migrating Atlantic Salmon, dredging will be limited to periods when juvenile stage salmonids are not passing through the vicinity of the proposed development. Work will be completed between 1st August and 31st March inclusive to remove the impact of these activities by avoiding April to July downriver run of smolts. This proposed timing of works would also avoid most of the upstream spawning migration of Sea Lamprey. It is proposed that dredged material will be used as fill material during land reclamation, thus completely eliminating disposal at sea during construction. This material has been assessed following site investigations and is suitable for use in the land reclamation. Additionally, European Eel, while not an Annex II species and therefore not a Qualifying Interest for either cSAC, which also migrates through the area at this time will not be impacted by dredging.

4.8 IMPACTS ON FISH DURING CONSTRUCTION PHASE - ADVERSE IMPACTS CAUSED BY SUSPENDED SOLIDS/SEDIMENT

Temporary Moderate Negative Impact

Local fishing interests have been concerned that the dumping of dredged spoil could negatively impact Shrimp or Lobster, although the disposal of dredge spoil in Inner Galway Bay in the past has not caused long-term adverse effects on the infaunal communities in the area (Roche, 2004). However, the material that will be removed after dredging and blasting (*i.e.* 1.815 million cubic metres of silt and sand material and 24,000 cubic metres of rock) will all be used as fill material for the land reclamation portion of the proposed development, so there will be no impact from the disposal at sea of construction dredge spoil.

Dredging and other construction activity will cause the level of suspended solids in the area to be temporarily increased. The geotextile mesh will be sized to retrain suspended solids in the land reclamation lagoons. The suction head of the Trailer Suction Hopper Dredger will be immersed in the softer soils to be dredged minimising silt suspension. The softer materials will not be dredged using a backhoe as this would result in a greater loss of fines. The stiffer materials will be lifted in a closing backhoe bucket to ensure the minimum loss of fines. The placing of dredged materials in lagoons will result in seawater being displaced from the lagoons and from the saturated soils. The soils are not contaminated and the discharged water will be filtered by a membrane lining of the lagoon walls and by the build up of soils on the membrane.

The turbidity caused by suspended solids can affect primary production by shading and increased sedimentation can disturb benthic communities. There is also the possibility of negative impact on Shrimp, particularly if solids are suspended during the breeding season. Newcombe and MacDonald (1991) state that high levels of suspended solids (typically of the order of 20,000 mg/L or more for exposure periods of 24 to 96 hours for smolts of several species) can be lethal for salmonids. The same authors also detail sub-lethal responses (including cellular damage and physiological stress) and behavioural responses (*e.g.* avoidance behaviour and alarm responses) to suspended solids.

The concentrations of suspended solids causing these responses were variable (from 6 to 650 mg/L for behavioural responses and from 14 to 1547 mg/L for sub-lethal responses) and are probably dependent on the duration of exposure of the fish to the suspended solids. Whitman *et al.* (1992) observed the effects on Pacific Chinook Salmon (*Oncorhynchus tshawytscha*) that were caused when volcanic ash was added to water under experimental conditions. When ash was added to a concentration of 350 mg/L the preference of the fish for home water (*i.e.* water from their natal river) was significantly reduced. This was apparently due to avoidance of the ash, rather than an inability to identify home water.

The avoidance behaviour of Cod and Herring to dredging-induced turbidity and the effects of sediment plumes on the buoyancy and mortality of Cod eggs and larvae have been studied as part of the Environmental Impact Assessment for the Öresund Link bridge-tunnel project between Denmark and Sweden (Westerberg *et al*., 1996). The avoidance threshold to suspended sediments of glacial clay of limestone origin was studied in an experimental saltwater flume and was found to be approximately 3 mg/l for both species. Adhering particles from sediment suspensions were shown to cause a loss of buoyancy for Cod eggs, while larvae showed increased mortality on exposure to sediment concentrations of 10 mg/l.

The adverse impacts of suspended solids of fish that have been recorded experimentally are generally at concentrations greater than 10 mg/l and often several orders of magnitude more than this. Results from the capital dredge sediment analysis (see Chapter 8) predict that concentrations of suspended material in the dredge plume will fall to concentration of 1mg/l or less within several hundred metres of the dredge site. It should be realized that negative impacts on fish from experimental data often followed prolonged periods of exposure, whereas fish in the vicinity of the site of the proposed development will have the opportunity to move away from areas affected by the dredge plume.

Mitigation: In order to minimise the effects of the construction phase on migrating Atlantic Salmon, events that could cause the suspensions of solids (i.e. blasting, drilling, dredging and infilling) will be limited to periods when juvenile stage salmonids are not passing through the vicinity of the proposed development. Work will be completed between 1st August and 31st March inclusive to remove the impact of these activities by avoiding April to July downriver run of smolts. This proposed timing of works would also avoid most of the upstream spawning migration of Sea Lamprey. It is proposed that dredged material will be used as fill material during land reclamation, thus completely eliminating disposal at sea during construction. This material has been assessed following site investigations and is suitable for use in the land reclamation. Additionally, European Eel, while not an Annex II species and therefore not a Qualifying Interest for either cSAC, which also migrates through the area at this time will not be impacted by dredging.

Dredging of sediments within 800m of the mouth of Lough Atalia will not occur during ebb tides. This measure is intended to avoid the possibility of suspended sediments entering Lough Atalia

The design of the proposed development includes the use of geotextiles to line the filled area and also incorporates the continuous gradual filtered release of dredged transport water. This will minimise the possibility of silt escaping back into the marine environment from the development. The geotextile mesh will be sized to retain suspended solids in the land reclamation lagoons. These lagoons are shown in Drgs 2139-2142 & 2139-2143 which outlines the various construction elements and shows the proposed areas where the lagoons will be formed as the land is reclaimed and Plates 21-24 of the Visuals includes images of the stages of development.

Suspended solids levels will be continuously monitored at a number of points in the vicinity of the works as part of the Environmental Management Plan. The position and distance of the sampling points will be agreed after consultation with the appropriate authorities and will be such that raised suspended solids concentrations do not occur at distances that are greater than the moderate areas of raised suspended sediments that have been predicted by capital dredge sediment plume model analysis.

4.9 IMPACTS ON FISH DURING CONSTRUCTION PHASE - ADVERSE IMPACTS CAUSED BY SUSPENDED SOLIDS/SEDIMENT – SALMONIDS

Short-term Potentially Significant Negative Impact
Salmonids are particularly sensitive to reduced levels of dissolved oxygen. Reduced dissolved oxygen levels are likely where dredging and other construction works mobilise sediments that consume oxygen. Solution of oxygen in water depends on water temperature and salinity. Oxygen saturation is 13 mg/L in fresh water at 4 °C and 7.4 mg/L in full strength seawater (*i.e.* 30 S_P) at 21 °C. Salmonids and other fish will have the opportunity to move away from areas of low oxygen concentration, but migration into and out of the River Corrib could be affected.

Mobilisation of toxic chemicals (*e.g.* try-butyl tin TBT, Polychlorinated Byphenyls PCBs), from sediment raised as a result of dredging and other construction activities, is a possibility. Raised levels of lead and zinc were found in some samples, which "*would be consistent with export of base metal ores*" (Mercury Analytical Ltd. report, 2000). Both PCBs and TBT accumulate in the environment, in sediments, fish and especially shellfish. Apart from the direct effects on the organisms themselves, fish or shellfish products with too great a level of this type of contaminant would be unfit for human consumption. In the year 2000, the sediments in the harbour channel were analysed for some heavy metals, TBT, di-butyl tin (DBT), hydrocarbons, pesticides and PCBs prior dredging works (in 2001). Since there will be no dumping of dredged silt or rock from the capital dredging operations, there will be no need for an application to the EPA for a dumping at sea permit and no need to determine the levels of lead and PCB congeners for that purpose.

Sediment chemical analysis (see above) in the proposed development area has shown that aluminium, mercury, cadmium, arsenic, nickel, iron and manganese levels were in line with previous findings and were not found in concentrations that were particularly elevated or of concern. Levels of polyaromatic hydrocarbons (PAHs) were less than are recorded in the Celtic Sea and the concentration of TBT was below that expected from values previously recorded by the Marine Institute. Recorded levels of PCBs were consistent with values recorded by the Marine Institute in the south-east Irish Sea and in Cork Harbour. Given that the more highly concentrated suspended solids concentrations predicted for the dredge plume are restricted to areas close to the dredge site and that these will fall rapidly due to deposition, the likelihood of a significant impact is low.

Mitigation: Suspended solids levels will be continuously monitored at a number of points in the vicinity of the works as part of the Environmental Management Plan. The position and distance of the sampling points will be agreed after consultation with the appropriate authorities and will be such that raised suspended solids concentrations do not occur at distances that are greater than the moderate areas of raised suspended sediments that have been predicted by capital dredge sediment plume model analysis.

4.10 IMPACTS ON FISH AS A RESULT OF POTENTIAL FOR SPILLAGES DURING CONSTRUCTION

Short-term Potentially Significant Impact
Pollution from accidental spillages of fuel or oily wastes from construction machinery may occur if a construction management plan has not been put in place.

Mitigation: All machinery used in the construction of the proposed development will be checked to ensure that it is well maintained and not likely to leak fuel, lubricating oils, greases etc. into the aquatic environment. Any onsite refueling or maintenance will be carried out on securely bunded temporary hard standing areas. All oily wastes generated will be stored in leak-proofs tanks for removal by a licensed operative holding a valid Waste Collection Permit. Dredgers will be re-fuelled at sea using best available practice to ensure no spillages into the designated sites.

4.11 IMPACTS ON FISH AS A RESULT OF USE OF CONCRETE DURING CONSTRUCTION

Short-term Potentially Significant Negative Impact (localized)
Uncured (wet) concrete will be used on site and in the event of accidental spillage into the bay, would act as a caustic pollutant, raising the pH in water. Uncured concrete in direct contact with water is toxic to aquatic life and dust liberated during the grinding of concrete can also create a pH problem.

Mitigation: Normal best construction practice with regard to the use and pouring of concrete will be adhered to. If concrete cannot be poured in dry protected areas away from water until full curing has taken place, particular attention will be paid to the quality and security of the shuttering used for pouring. Pre-cast concrete elements will be used wherever possible and these will be designed to allow for enhanced settlement of Flora and Fauna as reported in recent scientific papers (Firth 2013, Chapman and Brown 2011, Martins and Thompson, 2009). Any wash water contaminated with concrete will not be allowed to enter the marine environment and will be disposed of elsewhere. Contaminated equipment (*e.g.* concrete delivery trucks, pumping equipment and tools) will be cleaned where there is no possibility of the drainage of wash water to the marine environment. The design by using sheet pile and rock armour has ensured a minimal underwater concrete requirement. While the main quays will be concrete, these will be above tide level.

4.12 IMPACTS ON FISH DURING THE OPERATION PHASE DUE TO INCREASED SHIPPING NOISE

Permanent Neutral or Imperceptible Negative Impact
The hearing of salmon is restricted to frequencies below approximately 380 Hz and hearing sensitivity drops off steeply above 150 Hz (Hawkins and Johnstone, 1978). Knudsen *et al*. (1992, 1994) observed strong avoidance reactions from salmon smolts in response to underwater noise. These reactions were to low frequency noises at 10 kHz, while minimal reactions were shown to higher frequency noises at 150 kHz. These workers conducted experiments using pure sine waves, rather than more complex noises like boat noise.

However, Nedwell (cited in Solomon, 2001, p. 31) presented data showing that the noises produced by ships are low frequency (below 50 kHz), in the range with greatest behavioural impact for salmon. Moore and Ives (cited in Solomon, 2001, p. 31) detailed evidence of salmon smolts swimming away from boat sound in Southampton Water, UK. No dredging was taking place when the observations were made. These observations contradict those made by Westerberg on adult salmon (see above) and it is possible that adults are less affected by noise than are smolts. Assuming that the development of a deepwater dock would lead to the increased usage of Galway Harbour by shipping, any current impact on migrating smolts could be increased as a result. However, the range over which such responses can be caused would have a bearing on the possible impacts of shipping noise; the new deepwater dock would have the effect of moving large ships further from the mouth of the River Corrib.

Given that there is currently low frequency noise from large ships entering the existing harbour, that these are relatively localized to the vicinity of the actual individual vessel and that their duration in any particular area is short, coupled with the fact that the lesser number of larger vessels will be moved further from the area of the river mouth and the path of the anadromous fish as a result of the proposed development, significant negative impacts are not envisaged. The smaller marina vessels will not generate a significant level of noise.

Mitigation: Vessels approaching the Galway Harbour Extension area will be limited in their approach speeds thereby reducing the level of noise.

4.13 IMPACTS ON FISH DURING OPERATION PHASE CAUSED BY CHANGED RIVER FLOW AND SEDIMENT EXPORT

Permanent Neutral or Slight Positive Impact

The slight narrowing of the river mouth that would be one of the results of the construction of the proposed development means that the flow rate of the river as it enters the sea would be increased. The principal predicted impact on flow is the deflection of the Corrib outflow more southwards towards Mutton Island resulting in a concentration of flow along the proposed dredged channel past the marina breakwater and southwards (see Chapter 8, Water). Simulations indicate higher velocities in this channel than predicted for the existing dredge channel (*i.e.* as at present). Another impact on the flow regime is an increase in tidal velocity past the head of the breakwater, with velocities increasing from 0.1–0.15 m/s to 0.2 - .25 m/s.

The results of modelling indicate that the proposed development restricts the erosive flow to the proposed dredge channel immediately to its west. This may have the beneficial effect of reducing the dredging maintenance requirement (currently approximately 50 centimetres of silt is removed at roughly ten year intervals). The overall conclusion from the modelling is that the proposed port configuration will confine the high flows and critical bed shear to the approach channels and will not result in any erosive impact elsewhere.

To quote Chapter 8: "*Simulation of the fine sediment from the River Corrib showed the proposed development pushing the river plume and thus suspended sediment southwards out to sea past Mutton Island on the ebbing tide and away from the Renmore area only returning in a much more dilute plume on the flooding tide. The simulation results indicate a reduction of between 40 and 60% in fine sediment load east of the proposed development*."

Mitigation: None possible

4.14 IMPACTS ON FISH DURING OPERATION PHASE DUE TO CHANGES IN SALINITY REGIME

Permanent Slight Positive Impact

The impact of the proposed new structure will increase salinities immediately to the east of it under average River Corrib flows. This impact will be reflected under Corrib flood flow conditions and to a lesser extent under low flow conditions. Less significant changes (reduction in salinity) are predicted to take place in salinities levels (slight reduction) to the west of the structure and very minor changes are predicted for Lough Atalia or the waters beyond Mutton Island.

As a consequence of the proposed development, the Corrib plume will flow directly southwards and south southwest towards Mutton Island and thus more out to sea than at present, with no opportunity for the freshwater plume to directly disperse into the Renmore Bay area. On Neap tides the predicted changes will be significant east of the harbouir extension, with average increases in salinity of 2.2 to 4.8 psu and very minor changes elsewhere, including Lough Atalia. On Spring tides very significant changes in salinity will occur in the Renmore shoreline area, with increased salinities to 7.2 psu and 8.5 psu respectively. In Lough Atalia and the approaches off Nimmo's pier a slight reduction in median salinity concentrations of 1.29 psu is predicted. Further south along the new approach channel reductions in salinity of 5 psu are predicted.

Since migrating salmon are attracted by scent to the their natal waters, there may be a positive impact in that this will help returning fish to find the river mouth, rather than failing to do so and entering areas like Lough Atalia, as some are known to currently do. It will also help smolt reach the wider, safer salt waters.

Mitigation: None needed.

4.15 IMPACTS ON FISH DURING OPERATION PHASE DUE TO LIGHTING

Permanent Moderate Negative Impact
There is potential for lighting in the newly reclaimed land and along the new breakwater to negatively impact migrating fish (which prefer to migrate under cover of darkness and are somewhat deterred from passing through brightly illuminated areas) entering or leaving the River Corrib.

Mitigation: There will be mitigation through the use of energy efficient lighting in a configuration designed to provide the minimum lighting level required for safety. The lights used will be of a design that casts light downwards and landwards only and the lamp standards will be positioned in such a way that only the newly reclaimed land or new breakwater will be illuminated, not any areas of water.

4.16 IMPACTS ON FISH DURING OPERATION PHASE DUE TO POTENTIAL FOR INCREASED PREDATION OF MIGRATORY FISH BY SEALS

Permanent Potentially Significant Negative Impact
The IFI have expressed some concerns that the new harbour construction may provide additional haul-out sites for seals and that this could lead to additional predation on salmon and sea trout in the vicinity of the river mouth, where the fish have to migrate through a relatively confined area and may be especially vulnerable.

Mitigation: The design of the proposed with steel sheet pile to act as a toe for the rock armour will create a steep drop into the water and thus mitigate against the possibility of seal haul out areas being created in this area (mitigation by design).

4.17 IMPACTS ON FISH DURING OPERATION PHASE DUE TO INCREASED POTENTIAL FOR POLLUTION

Potential Serial Short-term Significant Negative Impact Events
Storm water from both the proposed development and the existing Phase 1 of the Galway Harbour Park might form a route whereby silt, spilled petrol and other oily wastes from the industries within the area and from parking places might enter the waters of Galway Harbour.

Mitigation: The stormwater from the existing Phase I of the Galway Harbour Enterprise Park currently discharges from three discharge points. It is proposed that these three discharge points will be linked up, as part of the Phase 2 development, so that only one discharge point for all the existing Harbour Enterprise Park will discharge storm water to the sea. This new system will divert storm water to a petrol interceptor fitted with a silt trap prior to its discharge to sea. In the event of an oil spill entering the storm water system, the use of one discharge point for all the existing harbour enterprise park will allow the contaminated water to be controlled more efficiently as the discharge of water to sea will be prevented by the use of a control valve. The discharge from the new lands will be as detailed in Drawing 2139-2214 all of which will have oil, grit interceptors and control valves to prevent contaminated water discharging to sea.

4.18 IMPACTS ON FISH DURING OPERATION PHASE DUE TO POLLUTION ASSOCIATED WITH WASTEWATER FROM OPERATIONS

No Impact

Since all foul sewage generated within the area of the proposed development will be piped to the existing pumping station (which has sufficient capacity for both the existing and the proposed developments) and then pumped into the Galway City main drainage network for treatment, the wastewater produced as a result of the proposed development will not have an impact. In the new development all shipping *etc*. will discharge to a direct system of foul drainage via pumps thus ensuring no spillages. Harbour bye-laws currently provide for effluent disposal in a safe manner.

Mitigation: None needed.

4.19 IMPACTS ON FISH DURING OPERATION PHASE DUE TO REGULAR MAINTENANCE DREDGING

Short-term Serial Localised Moderate Negative Impacts (similar to those that already occur)

Maintenance dredging, which takes place along the existing approach channel every ten years or so, would also be a periodic necessity for the proposed development. Maintenance dredging brings with it the impacts that would come from dredging and spoil disposal (*i.e.* temporary loss of infaunal communities and fish feeding areas, increased suspended solids loads, decreased dissolved oxygen levels, possible mobilisation of toxic compounds in the silt).

Before the harbour channel was last dredged (in August 2001), it was calculated that 80,000 m^3 of dredging spoil would be disposed of. Modelling work suggested that, after dumping, the thickness of settled material would drop to less than 1 mm within a radius of 450 metres from the edge of the dumping site. The same modelling work predicted that "resuspension rates were of a very low order and, therefore, the volume of material being resuspended is small enough to be deemed insignificant" (AQUAFACT report, 2001). The effects of the settling and possible resuspension of dredging spoil dumped as part of the maintenance works for the proposed development would be dependent on the amount of material dumped.

When maintenance dredging is required, it will be subject to licencing by the EPA. Spoil from maintenance dredging will be disposed of to an EPA permitted site located outside Natura 2000 sites.

Mitigation: None possible

4.20 IMPACTS ON FISH DURING OPERATION PHASE DUE TO POTENTIAL FOR INCREASED SUSPENSION OF BOTTOM SEDIMENT CAUSED BY INCREASED SHIP TRAFFIC

Permanent Slight Positive Impact
As the manoeuvres of large ships approaching the docks may cause the local suspension/re-suspension of some sediment from the bottom of the harbour, increased levels of shipping in the area might increase this effect. However, the greater depth (8 to 10 metres, compared with 3.4 metres in the current dredged channel) of water at the proposed new berths means that this effect would be reduced rather than increased.

Mitigation: Vessels approaching the Galway Harbour Extension area will be limited in their approach speeds thereby minimizing the resuspension of bottom sediments. Furthermore, due to water depth in the area the possibility of propellers resuspending sediments is minimal.

4.21 IMPACTS ON FISH DURING OPERATION PHASE DUE TO INCREASED POTENTIAL FOR INCREASED POLLUTION FROM SHIPPING

Potential Serial Short-term and Long-term Significant Negative Impacts
One of the purposes of the proposed development is to increase the amount of shipping using Galway Harbour. This would lead to an increased risk of hydrocarbon pollution from accidental spillages/ bilge flushing *etc*. Increased local shipping use might also increase the levels of antifouling compounds (*e.g.* tributyl tin or copper thiocyanates) in the local environment. These compounds tend to accumulate in receiving environments because of their very persistent nature. The Marine Institute do not have any data for TBT levels in sediments in Galway Bay (Dr. Margo Cronin, Marine Institute, pers comm.). The Sea Pollution (Miscellaneous Provisions) Bill, in enacting the International Convention on the Control of Harmful Antifouling Systems for Ships, made the reapplication of TBT paints to ships illegal at the beginning of the year 2003. The effect of this should be a gradual reduction in TBT levels in the environment. Galway Harbour Company's Environmental Management Plan deals with the requirements on shipping to ensure no spillages to the water (See Appendix 4.2).

Mitigation: A detailed spill response plan has been prepared (Oil Spill Contingency Plan Appendix 4.3). This will limit the negative effects of any spills. GHC has an Environmental Management policy to ensure that there are no spillages to the sea. All vessels will have a boom

4.22 IMPACTS ON FISH DURING OPERATIONAL PHASE DUE TO INCREASED POTENTIAL FOR RISK OF INTRODUCTION OF INVASIVE NON-NATIVE SPECIES BY SHIPPING

Potential Permanent Significant Negative Impact
Shipping and leisure craft from other ports increases the risk of the introduction of potentially harmful non-native species into Galway Bay. Plants and animals can settle on the hulls of vessels and be passively carried from port to port as the ships make their passages. No such species have been recorded to date.

Mitigation:

The area around the docks will be monitored on an on-going basis to record the occurrence of such species. If noted, possible remedial measures will be put in place to control the spread of such species.

5 IMPACTS ON BIRDS

5.1 IMPACTS ON BIRDS ASSOCIATED WITH INCREASED DISTURBANCE DURING CONSTRUCTION AND OPERATIONAL PHASES

Imperceptible Impact

There is potential for the large ship traffic that will occur as a consequence of the operation of the proposed development to cause disturbance to the tern colony on Rabbit Island. A colony of Common Terns has nested on a mooring dolphin in the River Liffey in Dublin Port since 1995 at least (Merne, 2004). This colony has increased from 238 pairs in 2002 to 400 pairs in 2009 (S. Newton, BirdWatch Ireland, *pers comm*.), so it can be concluded that the busy port traffic there has no negative impact on the colony. A study on breeding Common Tern in the U.S.A. (Burger, 1998) showed that speed boats and small private craft could cause the birds to take flight if they came close to the colony. The author recommended that craft should not come within 100 metres of the colony and that their speed should be limited whilst in the vicinity of it. It is to be expected that larger boats entering or leaving the harbour would be moving slowly down the dredged harbour channel and would not approach Rabbit Island closely, since the water around the island is too shallow for them. During the construction phase, Galway Harbour Company will direct that no small craft approach Rabbit Island closer than 100 metres during the bird breeding season (March – August). The April – July closed season on blasting, drilling, pile driving and infilling protects the Rabbit Island Common Tern colony from disturbance during these works.

Mitigation: None possible.

5.2 IMPACTS ON BIRDS ASSOCIATED WITH THE POSSIBILITY OF PHYSICAL DAMAGE CAUSED BY BLASTING AND PILE DRIVING DURING THE CONSTRUCTION PHASE

Potential Short-term slight negative impact on bird populations

In order to ensure that diving bird species are not present during blasting activities, a RIB will be used to deter species from the area.

5.3 IMPACTS ON BIRDS ASSOCIATED WITH LOSS OF FEEDING HABITAT

Permanent Slight Negative Impact

The loss of 5.6 hectares of muddy sand foreshore constitutes a loss of potential feeding areas for birds (particularly waders). However, the area of foreshore concerned is not a roosting site for wading birds and both available information for the area and bird survey results indicate that this area is not of significance for feeding or resting birds within the SPA. The loss of 23.89 hectares of marine habitat constitutes a loss of feeding area for divers, grebes, terns *etc*., although the concentrations of Wintering divers found at the site are not as high as those in other areas of inner Galway Bay. The loss of feeding habitat for marine birds is small in relation to the total area of marine habitat available within the SPA. Wintering divers are also well distributed along areas of the coast of Galway Bay to the West of the Inner Galway Bay SPA.

Mitigation: None possible.

5.4 IMPACTS ON BIRDS ASSOCIATED WITH INCREASED POSSIBILITY OF POLLUTION INCIDENTS DURING CONSTRUCTION AND OPERATIONAL PHASES

Potential Short-term Significant Negative Impact Events

A possible indirect negative impact of the proposed development on waterbirds is the increased possibility of harmful pollution incidents that the expected increase in marine traffic will bring with it.

In the past there used to be many small spillages in Galway Harbour docks. Recently, large fines have been imposed on vessels that spill oil and the occurrence of spills has decreased. There was one recorded spill in 2004– 550 litres of gas oil and one recorded spill of 100 litres of oil in 2003 (Captain Brian Sheridan, Galway Harbour Master, pers comm.).

Mitigation: Detailed Spill Response and Construction Waste Management Plans have been prepared (Appendix 4.3). This will limit the negative effects of any spills.

6 IMPACTS ON MAMMALS

6.1 IMPACTS ON MARINE MAMMALS DUE TO DISTURBANCE DURING THE CONSTRUCTION AND OPERATIONAL PHASES OF THE DEVELOPMENT

Temporary Slight Negative Impact

The major source of potential negative impacts on local aquatic and marine mammals will come from underwater blasting, drilling and pile driving. Noise and vibration will also be generated by the general construction activity (dumping of fill material, use of heavy goods vehicles *etc.*) at the site. Sound waves are propagated over long distances through water and there is evidence to suggest that sea mammals are likely to be very sensitive to loud noises. Most of the noise caused by shipping, dredging and drilling is of low frequency (approximately 5 to 160 Hz).

Possible indirect negative impacts of the operational phase of the proposed development on marine mammals are: increased disturbance from shipping noise, the increased possibility of injury caused by impact of ships and their propellers with marine mammals and the increased possibility of harmful pollution incidents that the expected increase in marine traffic will bring with it.

The sea is an environment that is naturally a relatively high noise environment. Cetaceans in particular have evolved ears that function well within this high natural background or ambient noise and which may be more resistant to hearing damage than land mammals (Ketten, 2004). Crum and Mao (1996) calculated that the exposure of marine mammals to 500 Hz sounds at sound pressure levels of 210 dB re. 1 μPa could cause bubble growth that could theoretically cause 'the bends'. Finneran *et al*. (2000) measured the hearing thresholds of Bottlenose Dolphins and Belugas (*Delphinapterus leucas*) that had been exposed to noises that were designed to mimic those produced by distant explosions. No threshold shifts (*i.e.* deafness) were observed in these experiments, but disruption of trained behaviour was noted at distances of several kilometres from the theoretical explosion points.

While mysticete (*i.e.* baleen, or non-toothed) whales may be affected by low frequency noise due to their use of low frequency infrasounds for communication, this type of cetacean is not at all common in the area (one known record of a stranded Minke Whale since 1970, see Table 7.29, above). Odontocete (toothed) cetaceans, a group that includes Short-beaked Common Dolphin, Harbour Porpoise and Bottle-nosed Dolphin, are most sensitive to sounds in the frequency range 10 kHz to 60 kHz (Vella *et al*., 2001). As far as disturbance by shipping goes, the group of Short-beaked Common Dolphin that are regularly found in the area often follow ships entering and leaving Galway Harbour. In addition, Harbour Porpoise (a species that is considered shy) are often observed in areas of intense shipping activity (Hoffman *et al*., cited in Vella *et al*., 2001, p.46).

Both Harbour Seal and Grey Seal are members of the phocinid or true seal group. The lowest limit of hearing sensitivity measured for Harbour Seal was 100 Hz, but a noise level of 96 dB was necessary for this to be possible (Kastak and Schusterman, cited in Vella *et al*., 2001, p. 48). The same workers found that there was intraspecific variation in the hearing ability of this species (*i.e.* different individuals had varying hearing abilities). It has been claimed that, if phocinid seals can perceive noise in the frequency range below 1000 Hz (1 kHz), they are probably not able to hear it above general ambient noise levels (Vella *et al*., 2001). It seems, therefore, that seals are unlikely to be significantly affected by the low frequency noises that would be produced by drilling, dredging or by boat noise.

Acoustic Deterrent Devices (ADDs) are used by some fish farms and fisheries to deter seals that might otherwise prey on stocked fish. These devices typically produce strong pulse noises in the range 8 to 17 kHz (much higher frequencies than boat or construction noise) at levels of 175 to 210 dB (Vella *et al*., 2001; Gordon and Northridge, 2002). Some individual seals become habituated to even this loud, high frequency noise.

All of the mammal species found in the local marine environment are particularly mobile. Although there may be some temporary disturbance during the construction phase of the proposed development, there are large areas of adjoining suitable habitats into which seals, dolphins and Otter can move. Since these mammals are accustomed to ambient water noise and the noise generated by the current harbour and its activities, no direct long-term negative impacts of the proposed development on mammal populations in the area is anticipated.

However, the blasting phase of the development construction has the potential to cause serious negative impacts (*e.g.* including injury and possible death) on local cetaceans and seals. The design of the drill holes, their depths and the amount of explosives used has minimised the numbers of blasts, the number of blasting days and the total period over which the blasts would be staged during the construction period.

Using available information and current suggested best practice (Southall *et al*., 2007), it has been calculated (see Chapter 10, Noise and Vibration) that the impact threshold distances for physical damage caused by dredging (worst case scenario is for backhoe dredging of rock in particular of which there is less than 1.3% of the total dredging quantity i.e. 24,000 m^3) at the site are up to 64 metres for seals and 16 metres for Harbour Porpoise (based on an unlikely 24 hour exposure at that distance). The impact threshold distances for disturbance caused by dredging at the site are up 128 metres for seals and one kilometre for Harbour Porpoise (all based on a 5 minute exposure at that distance). There are no significant seal haul outs within this distance of the dredging site. There will be a constant mammal watch and there will be a gradual build up of noise to allow time for mammals not in view but within earshot, to move out of range i.e. a “soft start” to the work.

Mitigation: Blasting will not be permitted if cetaceans or seals are sighted within one kilometre of the blast site; this area is defined as the exclusion area. Marine Mammal Observers will take up position before a day’s blasting begins. They will be equipped with binoculars, telescopes and tripods with which to watch for the animals, and two-way radios with which to communicate with each other and the explosives engineers. Blasting will not occur if a seal or cetacean is sighted within one kilometre of the blast site, or for a period of 30 minutes after one has been sighted within the ‘exclusion area’. Observers will use Mutton Island and Hare Island as watch points. A Marine Mammal Watch Plan giving full details of the methodology and standard operating procedures for the blasting watches will be carried out before blasting works begin.

The IWDG runs a national strandings scheme that covers Galway Bay. It is anticipated that the project team will arrange with IWDG to receive news of any strandings that occur in the area during the construction period, but it is further proposed that:

i. after episodes of blasting a search party will be sent out in a RIB to search the area around the blast site for dead or injured seals or cetaceans.
ii. a public awareness campaign will be launched in which members of the public are encouraged to report dead or injured seals in the inner Galway Bay via a designated phone line.

6.2 IMPACTS ON MARINE MAMMALS DUE TO DISTURBANCE FROM PILE DRIVING DURING THE CONSTRUCTION PHASE OF THE DEVELOPMENT

Temporary Potentially Moderate Negative Impact

Impact threshold distances for physical damage caused by pile driving at the site are up to 4 metres for both seals and Harbour Porpoise. The impact threshold distances for disturbance caused by pile driving at the site are up to 64 metres for both seals and Harbour Porpoise.

Impact threshold distances for physical damage caused by blasting at the site are up to 500 metres for seals and 128 metres for Harbour Porpoise. The impact threshold distances for disturbance caused by blasting at the site are up to one kilometre for seals and 256 metres for Harbour Porpoise.

Mitigation: Pile driving will not be permitted if cetaceans or seals are sighted within one kilometre of the blast site; this area is defined as the exclusion area. Marine Mammal Observers will take up position before a day’s pile driving begins. They will be equipped with binoculars, telescopes and tripods with which to watch for the animals, and two-way radios with which to communicate with each other and the explosives engineers. Pile driving will not occur if a seal or cetacean is sighted within one kilometre of the blast site, or for a period of 30 minutes after one has been sighted within the ‘exclusion area’. Observers will use Mutton Island and Hare Island as watch points. A Marine Mammal Watch Plan giving full details of the methodology and standard operating procedures for the blasting watches will be carried out before pile driving works begin.