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Our Ref: BR 7476-02-06 30th September 2022

Your Ref: PA 0033

The Chairperson

An Bord Pleanála

64 Marlborough Street

Dublin 1

RE: PA0033 - Galway Harbour Extension – Renmore and Townparks Townland, Galway
Compensatory Measures Proposal
Response to An Bord Pleanála letter of 20 October 2021

Dear Sir/Madam,

We refer to your letter of 20 October 2021 which enclosed the letter of 3 August 2021 from the National Parks and Wildlife Service ("NPWS") and requested our submissions and observations on same.

We have actively engaged in constructive interactions with the NPWS in order to address the items identified in that correspondence and we enclose herewith our response to An Bord Pleanála ("ABP"). The Compensatory Measures now include additional land at Tawin West and adjustments to the previous proposals following the engagement with the NPWS.

The response package includes the following documentation:

1. Response to An Bord Pleanála arising from NPWS Queries on Compensatory Measures Plan
2. Compensatory Measures Plan, Accompanying Measures and Additional Environmental Benefits
3. 2022 Addendum to Natura Impact Statement, to include Consideration of the Compensatory Measures, Accompanying Measures and Environmental Benefits

Three hard copies and two electronic copies have been posted to you and we will also forward a copy by email.

To the extent that ABP consider that a tri-partite meeting would be of benefit to the process in order to expedite matters, we would be glad to make ourselves available and NPWS have also indicated a willingness to participate in same.

Please acknowledge receipt of the documents at your convenience and we trust that the response is to your approval.

Yours faithfully,

_____

Brendan Rudden

Senior Engineer

For and on behalf of TOBIN Consulting Engineers

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Galway Harbour Company

Galway Harbour Extension

Response to An Bord Pleanála arising from National Parks and Wildlife Service Queries on Compensatory Measures Plan

TOBIN CONSULTING ENGINEERS

An Bord Pleanála (Ref: 61.PA 0033)

AQUAFACT APEM Group

DOCUMENT AMENDMENT RECORD

Client:	**Galway Harbour Company**
Project:	**Galway Harbour Extension**
Title:	**Response to An Bord Pleanála arising from National Parks and Wildlife Service Queries on Compensatory Measures Plan**

PROJECT NUMBER: 7476				**DOCUMENT REF: Response Document**			
C1	Minor comments after meeting	BOC	22.07.22	BR	25.07.22	JF	25.07.22
B	Draft for review	BOC	31.05.22	BR	31.05.22	JF	31.05.22
A	Draft for review	BOC	13.05.22	BR	13.05.22	JF	13.05.22
Revision	**Description & Rationale**	**Originated**	**Date**	**Checked**	**Date**	**Authorised**	**Date**
TOBIN Consulting Engineers / AQUAFACT APEM Group							

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1. Introduction

1.1. Overview

In a letter dated 20th October 2021, An Bord Pleanála (ABP) made Galway Harbour Company (GHC) and the consulting engineers appointed by GHC for the Galway Harbour Extension (GHE), TOBIN, aware of issues raised by the National Parks and Wildlife Service (NPWS) in its review of the Compensatory Measures Report (CMR) (dated 25th April 2019) prepared on behalf of the GHC concerning the impacts on habitats due to the proposed GHE project. The issues raised are outlined by NPWS in a letter dated 3rd August 2021. In the letter, which is included in **Appendix A** below, NPWS requested GHC to make a submission in response to the issues raised. The issues raised by NPWS in the letter were:

> '*questions outstanding as to the **scale of the benefits** that will arise from some measures, and the precise nature of the **legal arrangements** that are to be implemented to ensure long-term effectiveness and sustainability'.*

The letter requested clarification as to the **scope of the measures**. Specifically, clarification was requested on whether the Compensatory Measures were proposed in relation to:

> '*adverse effects that will arise solely as a result of the proposed development…, or in relation to adverse effects arising in combination with the earlier habitat losses that occurred….*' - **Topic A**

The NPWS also sought clarification with respect to the measures proposed for and the assessments undertaken for:

- Perennial Vegetation of stony banks [1220] - **Topic B**
- Reef [1170] and Mud and Sand Flats [1140] - **Topic C**
- Atlantic Salt Meadows (*Glauco-Puccinellietalia maritimae*) - **Topic D**

The NPWS also sought clarification regarding the proposed:

- Long Term Management of the Site - **Topic E**

On 29th November 2021, GHC held a consultation meeting with NPWS in order to ensure that there was a clear understanding of the issues raised in the letter. During the discussions, NPWS provided advice and made recommendations on amendments to the Compensatory Measures and highlighted further survey work and assessments required to address the Topics raised. To keep NPWS appraised of GHC progress on amendments, survey work and assessments, and to gain feedback and final approval of the measures to be included in the final Compensatory Measures Plan (CMP), additional consultation meetings were held on the 8th of December 2021 and the 3rd, 18th and 22nd of February 2022.

1.2. Purpose of this Report and Report Format

The purpose of this document is to provide responses to ABP and the NPWS arising from the NPWS requests for clarifications outlined in the letter (dated 3rd August 2021) while taking into account advice and recommendations made to GHC by NPWS during consultation discussions. This report has been used to inform the finalisation of the CMP.

The NPWS questions and requests for clarification with regard to **Topic A** though **Topic E** presented in the letter (dated 3rd August 2021) are provided in the tables in **Section 2** through **Section 6**, alongside brief summary responses.

For **Topic B**, **Topic C** and **Topic D** technical responses to the questions and requests for clarifications are presented respectively in **Section 7**, **Section 8** and **Section 9**.

The full set of Compensatory Measures that are included in the final CMP are listed in **Section 10** and are contained within the CMP report of July 2022, submitted herewith. An Bord Pleanála (ABP) conducted an Appropriate Assessment (AA) of the Galway Harbour Extension (GHE) and concluded that the development will cause:

- Direct and Permanent Loss of 5.93ha of [1170] Fucoid Dominated Reef habitat and [1140] Mud and Sand Flat habitat of the Galway Bay Complex Special Area of Conservation (SAC), and the,
- Loss of perennial vegetation of stony banks [1220] (0.35 ha) due to the sheltering effect of the harbour extension will also have a significant adverse effect on the integrity of the SAC.

The AA also ruled out beyond reasonable scientific certainty any significant effects to any other Qualifying Interests of the Galway Bay Complex SAC or any other SACs.

The AA also ruled out beyond reasonable scientific certainty any significant effects to the Galway Bay Special Protection Area (SPA) or any other SPAs.

The Compensatory Measures[1] for the GHE development will provide:

- 17.790 ha of the Intertidal habitat at Mweeloon which equates to a compensatory ratio of 3 : 1 (*i.e.* 17.790 ha : 5.930 ha)
- 0.844 ha of the stony bank at Tawin West which equates to a compensatory ratio of 2.411 : 1 (*i.e.* 0.844 ha : 0.350 ha)

During consultation meetings NPWS requested GHC to undertake a series of surveys at Tawin west and commission a technical note on coastal erosion and flood risk in the area; responses to address these requests are presented in **Section 11** below.

It should be noted that the final CMP also includes details of actions (termed Accompanying Measures) that will be implemented by GHC to supplement the Compensatory Measures. The Accompanying Measures are detailed in full in Section 3 of the CMP. Together the Compensatory Measures and Accompanying Measures will also provide additional environmental benefits in the Tawin West and Mweeloon areas. These environmental benefits are detailed in full in Section 4 of the CMP.

The Accompanying Measures proposed in the Plan will help manage pressures affecting the habitats and improve the Conservation Status of the habitats area at Mweeloon and Tawin West.

The historic development of the Galway Harbour Enterprise Park (GHEP) in the mid-1990s under planning permission reference number 68/95 resulted in the loss of some areas of Intertidal, stony bank and salt marsh habitats. The areas of habitat lost due to the GHEP are:

- 8.580 ha of Intertidal habitat,
- 7.390 ha of salt marsh, and
- 0.280 ha of stony bank.

[1] 17.790ha (65%) of the 27.331ha of Intertidal at Mweeloon and
0.844ha (75%) of the 1.124ha of stony bank at Tawin West is allocated for compensatory measures.

Adjacent to the Compensatory Areas, the following Accompanying habitat areas[2] are put forward to address these historic losses;

- 9.541 ha of Intertidal habitat at Mweeloon which equates to a ratio of 1.11 : 1 (*i.e.* 9.541 ha : 8.580 ha),
- 14.468 ha of salt marsh habitat at Mweeloon and at Tawin West which equates to a compensatory ratio of 1.96 : 1 (*i.e.* 14.468 ha : 7.390 ha), and
- 0.280 ha of stony bank at Tawin West which equates to a ratio of 1 : 1 (*i.e.* 0.280 ha : 0.280 ha, without counting the 3.111 ha of stony bank habitat at Mweeloon)

1.3. Summary

Topic A - Scope of Measures: In a letter (dated 1st March 2022) ABP confirmed to NPWS that the adequacy of Compensatory Measures should be considered for those habitats impacted by the GHE only.

The in-combination assessment presented in the original NIS that was prepared for the GHE dealt with the Galway Harbour Enterprise Park (GHEP). Habitat areas which are subject to Accompanying Measures have been allocated to address historic losses associated with GHEP.

Topic B - **Perennial vegetation of stony banks [1220]:** Of particular note are the changes to the compensatory habitat areas presented in the CMR based on recommendations made by NPWS.

In summary; the Compensatory Areas outlined in the CMR included an area of lands and shoreline at Lurgan Island and Mweeloon that contain Intertidal and stony bank habitats see **Figure 1-2**. The stony bank habitat area at Mweeloon extends all along the northern shore from Tawin Island, through Lurgan Island and as far as the eastern limit of the Compensatory Area. It was recommended by the NPWS that rather than using the stony bank habitat at Mweeloon as compensatory habitat an alternative more suitable area of stony bank habitat located to the west of the Mweeloon Compensatory Area be included in the final CMP. Following landowner negotiations and a series of surveys undertaken on behalf of GHC, an area (herein referred to as Tawin West) was selected for inclusion in the CMP. Blake and Kenny Solicitors confirmation regarding the new Land Purchase Agreement (Tawin West) is included in Appendix D. The Mweeloon Compensatory Area and the Tawin West Compensatory Area that are included in the final CMP (dated 05.05.2022) are shown in **Figure 1-1**. The Compensatory Measures for stony bank habitat are presented in full in Section 2.2 of the final CMP and summarised in **Section 10** below.

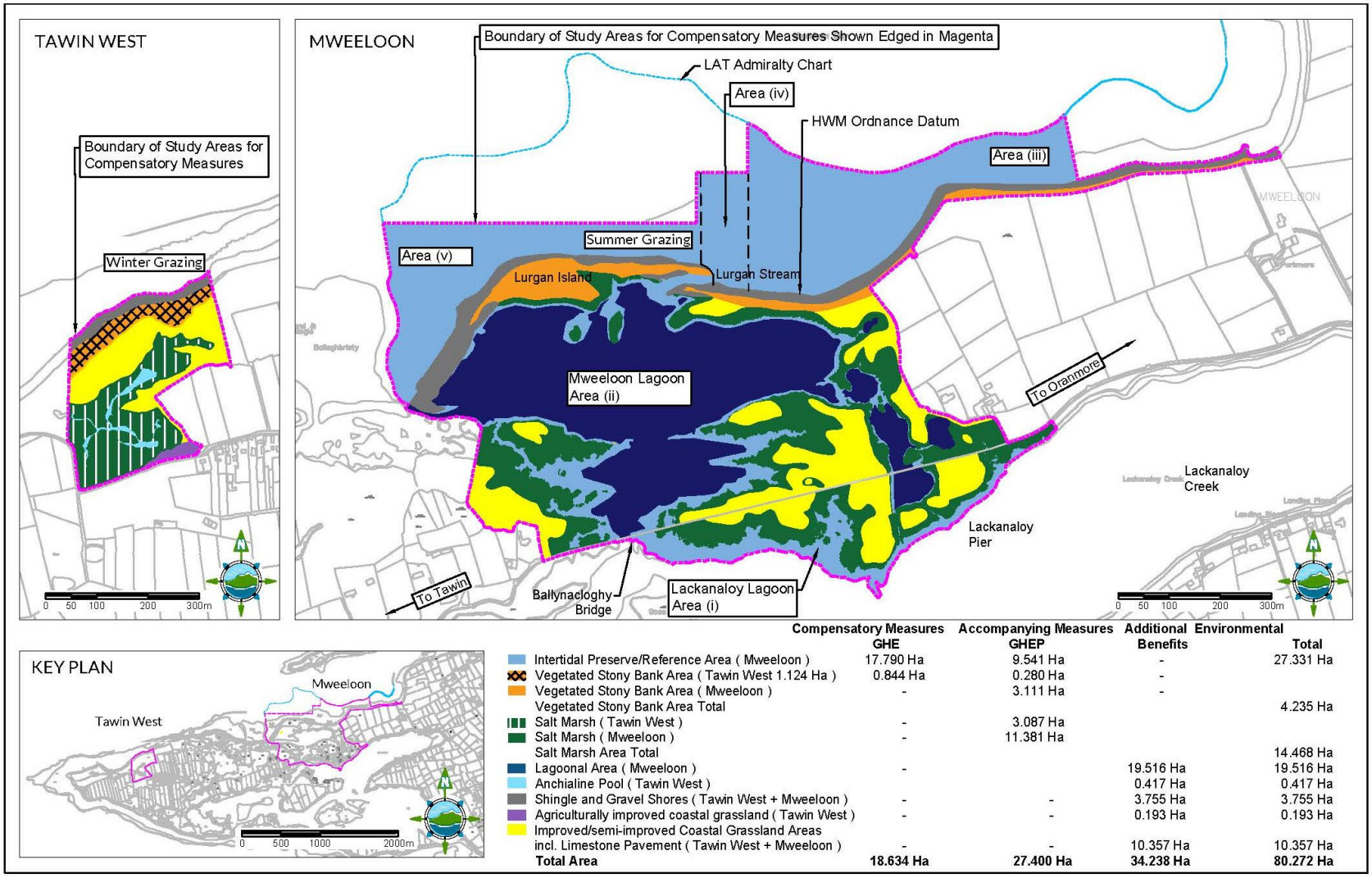
At Tawin West Compensatory Measures will be set in place to regulate grazing to reduce overgrazing and dunging and to a lesser extent, poaching of the habitat. There will be no grazing between the April 1st and the August 31st. A light grazing regime will be implemented between the September 1st and the March 31st at a grazing intensity of between 0.5 to 1.0 LU per hectare.

The lands outside of the areas of stony bank habitats within the Compensatory Area at Tawin West comprise coastal grassland and salt marsh habitat. These areas will be subject to the same grazing regime outlined above which will benefit both the vegetation and birds of the area.

[2] 9.541ha (35%) of the 27.331ha of Intertidal at Mweeloon and 0.28ha (25%) of the 1.124ha of stony bank at Tawin West is allocated for the Accompanying Measures.

It should be noted that while the stony bank habitat area in the Mweeloon Compensatory Area has been replaced by stony bank at Tawin West as compensatory habitat, these habitat areas at Mweeloon are included in the final Compensatory Measures monitoring and actions programme. Specifically, as part of the programme, GHC will undertake a series of actions at Mweeloon that will complement the Compensatory Measures. The actions, which are referred to as Accompanying Measures in the CMP, will help improve the Conservation Status of stony bank habitat at Mweeloon.

Other Accompanying Measures presented in the CMP will also help improve the Conservation Status of other habitats, including intertidal habitat, salt marsh and stony bank at Mweeloon, and salt marsh and stony bank at Tawin West. The Accompanying Measures are detailed in Section 3 of the final CMP.



	Compensatory Measures GHE	Accompanying Measures GHEP	Additional Environmental Benefits	Total
Intertidal Preserve/Reference Area (Mweeloon)	17.790 Ha	9.541 Ha	-	27.331 Ha
Vegetated Stony Bank Area (Tawin West 1.124 Ha)	0.844 Ha	0.280 Ha	-	
Vegetated Stony Bank Area (Mweeloon)	-	3.111 Ha	-	
Vegetated Stony Bank Area Total				4.235 Ha
Salt Marsh (Tawin West)	-	3.087 Ha		
Salt Marsh (Mweeloon)	-	11.381 Ha		
Salt Marsh Area Total				14.468 Ha
Lagoonal Area (Mweeloon)	-		19.516 Ha	19.516 Ha
Anchialine Pool (Tawin West)			0.417 Ha	0.417 Ha
Shingle and Gravel Shores (Tawin West + Mweeloon)	-	-	3.755 Ha	3.755 Ha
Agriculturally improved coastal grassland (Tawin West)	-	-	0.193 Ha	0.193 Ha
Improved/semi-improved Coastal Grassland Areas incl. Limestone Pavement (Tawin West + Mweeloon)	-	-	10.357 Ha	10.357 Ha
Total Area	**18.634 Ha**	**27.400 Ha**	**34.238 Ha**	**80.272 Ha**

Figure 1-1: Habitats within Compensatory Areas.

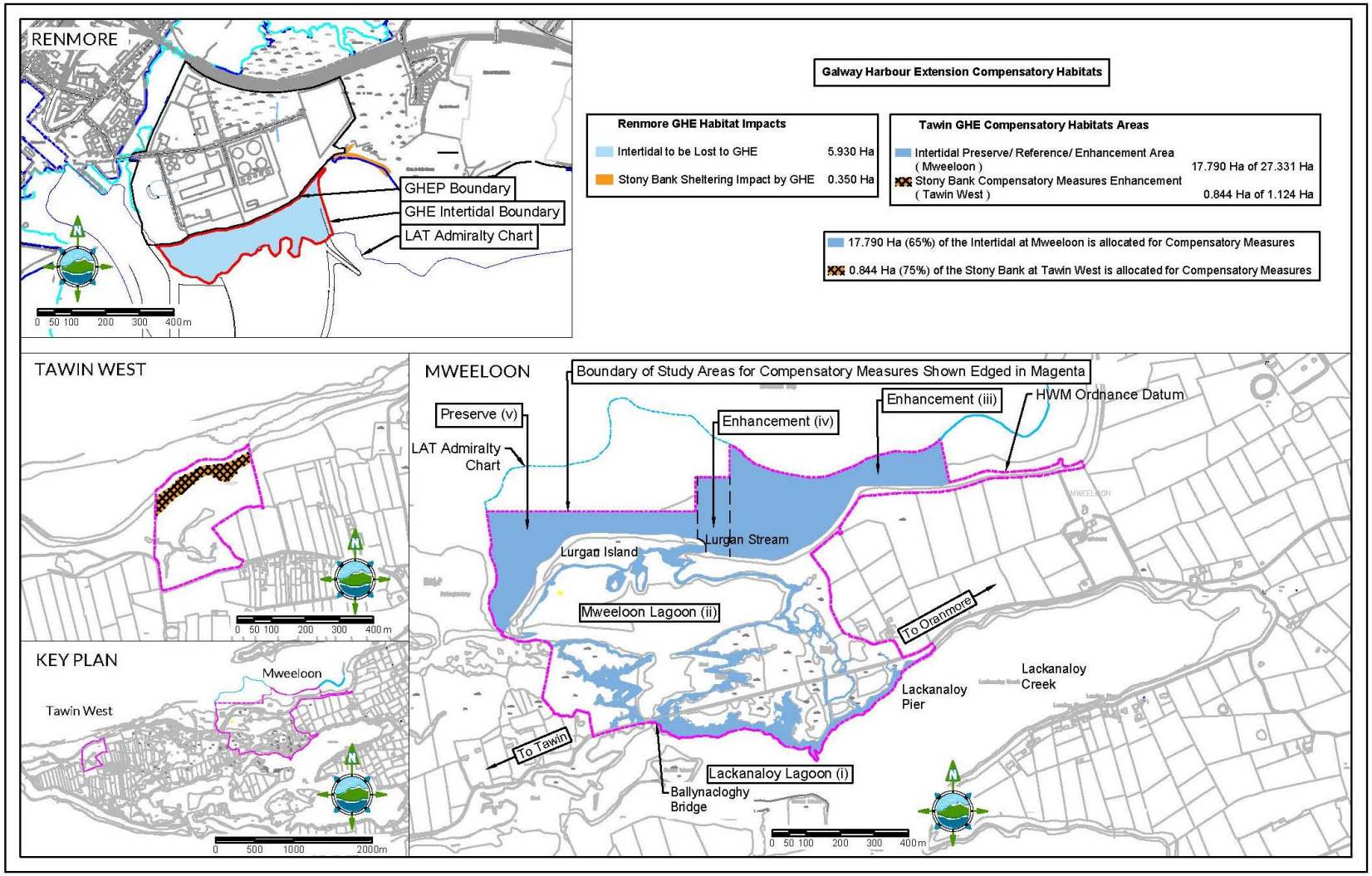


Figure 1-2: Compensatory Measures.

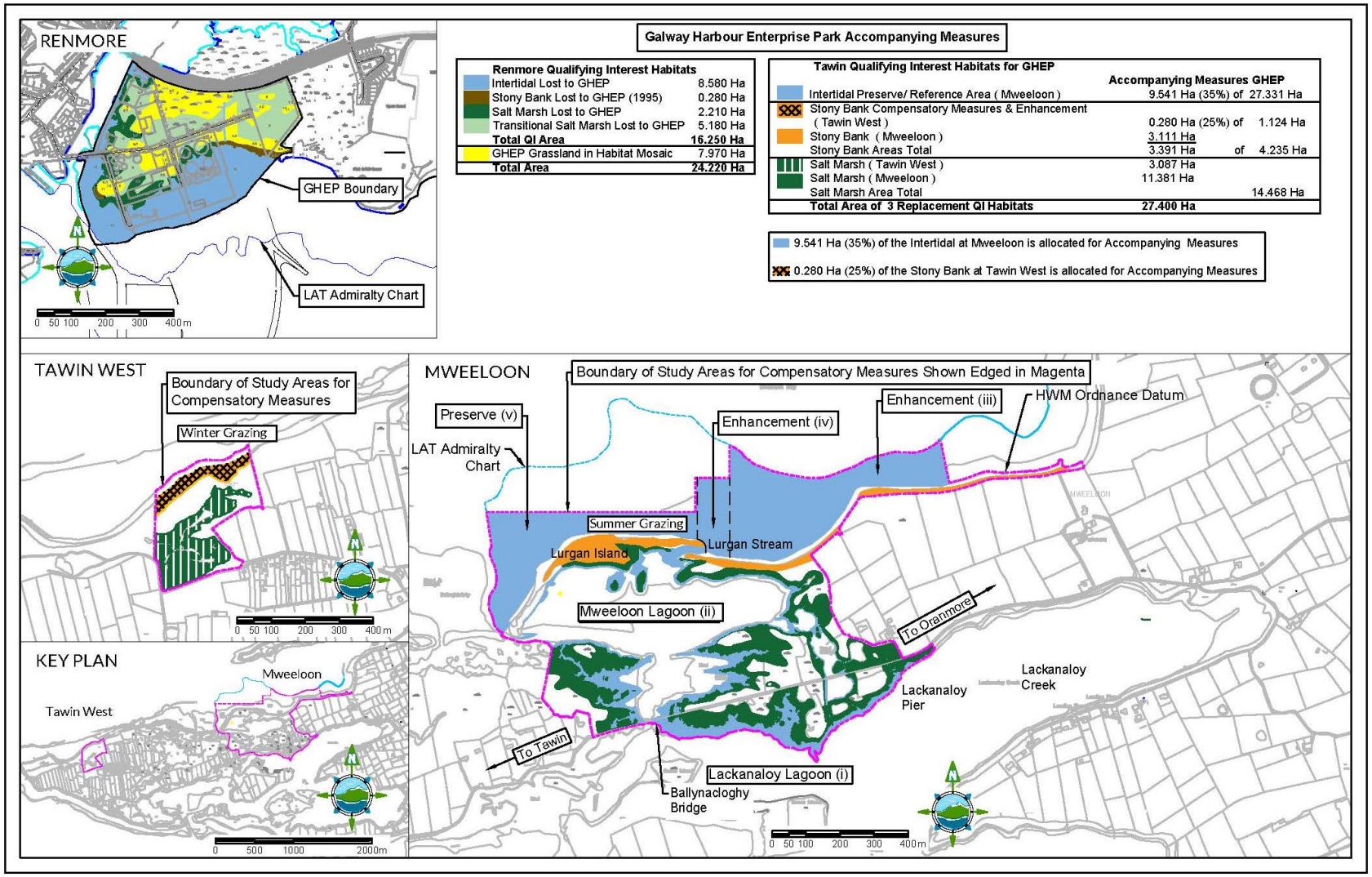


Figure 1-3: Accompanying Measures

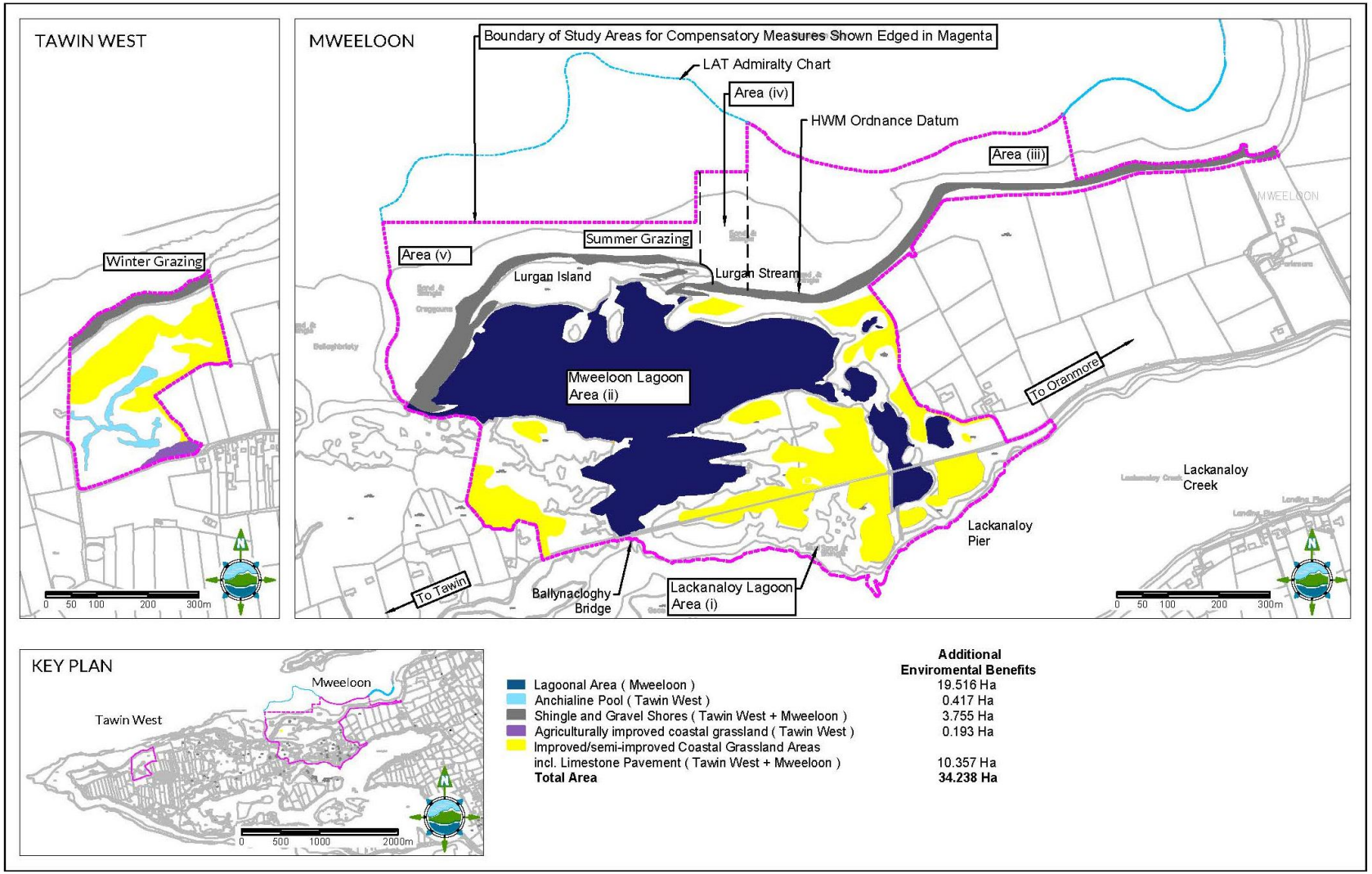


Figure 1-4: Additional Environmental Benefits - Habitat Areas.

Topic C - Reef [1170] and Mud and Sand Flats [1140]: Following consultation discussions it was confirmed to NPWS that the measures to be employed as part of the CMP to control the invasive tunicate *Didemnum* will evolve depending on results *etc* and that the efficacy of the treatment will be checked shortly after use and repeated if necessary to ensure that satisfactory control is achieved.

It should be noted that the response to **Topic C** presented below also takes into consideration reports prepared for ABP by Dr. Bastreri of Marine Planning Matters Environmental Consulting Ltd, and the request for further information issued to GHC by ABP. The reports prepared by Dr. Bastreri (dated September 2019 and February 2020) were issued to GHC by ABP on 1st December 2021.

In the September 2019 report, Dr. Bastreri outlined the findings of his review of the CMR (dated 25th April 2019). Based on the findings of the review, ABP issued a request for further information (RFI) to GHC on 7th October 2019 in relation to 10 points. In response to this RFI, GHC issued a report to ABP on 19th December 2019 titled Compensation - Reply to Further Information.

The report prepared by Dr. Bastreri (dated February 2020) assessed the Compensation - Reply to Further Information report (dated 19th December 2019). In summary, Dr. Bastreri concluded that there were no outstanding issues for 9 (of the 10) questions raised by ABP. Dr. Bastreri concluded that issues remained related to the sampling strategy put forward by GHC for benthic habitats and made recommendations regarding the sampling strategy. These recommendations have been implemented when preparing the response to **Topic C**.

Topic D - **Atlantic Salt Meadows (*Glauco-Puccinellietalia maritimae*):**

Following discussions with NPWS it was agreed that Atlantic Salt Meadows would be included as part of the Accompanying Measures of the CMP.

Following close consultation and discussions with the current owners and lessees of the lands at Mweeloon the proposed grazing regime for the area, *i.e.* the implementation of a light grazing regime between the May 1st and the October 31st, will be followed. Grazing of the habitats during these months will be closely monitored in order to ensure that a favourable conservation status is achieved for the salt marsh habitat.

As noted above for **Topic B** above there will be no grazing at Tawin West between the April 1st and the August 31st, with a light grazing regime implemented between the September 1st and the March 31st. The lands outside of the areas of stony bank habitats within the Compensatory Area at Tawin West which comprise coastal grassland and salt marsh habitat will be subject to the same grazing regime.

Topic E - Long Term Management of the Site: NPWS requires certainty around the long-term management of the Compensatory Area and certainty around the implementation of the management measures set out in the CMP. GHC has entered into contracts for the purchase of the required lands and control of the aquaculture licences, subject to planning, so the long-term implementation can then be achieved by a condition in the planning permission for GHE where the role of and the relationship between the applicant, the Local Authority and NPWS is set out and the requirements for annual reports etc. are all clarified. In line with the requirements under this condition, NPWS would receive reports after same have been submitted to the relevant planning authority and there would be provision for annual meetings especially if there are issues which require resolution on site.

Annual Reports on the Implementation of the Compensatory Measures Plan will be prepared and submitted to the Planning Authority and to NPWS/ DHLGH. The Annual Report will include a section describing monitoring activities, results and any recommendations arising for the adaptation of the Compensatory Measures, in view of the monitoring results. It is proposed that Annual Meetings with

the Planning Authority and NPWS/DHLGH will be convened to discuss the Annual Reports and any modifications/ adaptations that are recommended, for their approval. If matters of significance arise in the intervening months that may warrant more immediate amendment of a compensatory measure as permitted under lease conditions, approval of same will be sought by correspondence or by an extraordinary meeting, the latter on request.

Compensatory Measures Plan Implementation

It is expected that the implementation of the CMP will be overseen by Galway City Council ("GCC") as the planning authority for the Galway Harbour Extension

The envisaged implementation approach is that an annual report will be prepared by Galway Harbour Company ("GHC") and their specialist team in relation to the monitoring and management of the compensatory measures areas, adjacent areas of accompanying measures and additional environmental benefits, all in line with the CMP.

This annual report will be submitted to GCC.

The planning authority (GCC) is expected to determine the methodology and procedures for implementation, including the circulation of the annual report to the relevant stakeholders, one of which will be NPWS, and perhaps Galway County Council and others as GCC consider appropriate.

It is envisaged that the implementation will include an annual meeting of all of the stakeholders, including GHC, and will allow for more frequent meetings if required.

The implementation is expected to include site visits at appropriate seasonal times by the relevant stakeholders.

For example, there may be a site visits in early Spring and again in September before and after the appropriate growing seasons on the lands.

The annual report will then be submitted to GCC before the year end in order to allow time for GCC, NPWS and other relevant stakeholders to review the findings and make recommendations as required ahead of the next spring season.

2. Topic A - Scope of Measures

Table 2.1: NPWS Observations on Scope of Compensatory Measures Presented in CMR.

NPWS Key Message	Summary Response	Technical Response
In the NPWS letter dated 3rd August 2021, clarification was requested as to whether the compensatory measures are proposed for the losses/effects arising on the SAC as a result of the current proposed development alone or in combination with losses/effects arising on the SAC due to the reclamation of land in the area carried out in the mid-1990s to create the Galway Harbour Enterprise Park.	In a letter (dated 1st March 2022) ABP confirmed to NPWS that the adequacy of Compensatory Measures should be considered for those habitats impacted by the GHE only. The in-combination assessment presented in the original NIS that was prepared for the GHE dealt with the Galway Harbour Enterprise Park (GHEP). Habitat areas which are subject to Accompanying Measures have been allocated to address historic losses associated with GHEP.	N/A

3. Topic B - Perennial Vegetation of Stony Banks

As outlined in **Section 1.2** above, the Compensatory Area in the CMR (dated 25th April 2019) included an area of lands and shoreline at Mweeloon containing Intertidal and stony bank habitats. Based on NPWS advice provided to GHC during consultation meetings, an alternative area of stony bank habitat more suitable for inclusion in the CMP was identified at Tawin West (to the west of the original Compensatory Area). The Compensatory Measures proposed for the stony bank Habitat at Tawin West, which are presented in detail in Section 2 of the CMP, are summarised in **Section 10** below.

The stony bank habitat within the Mweeloon Compensatory Area does not form part of the GHE compensatory habitat area but will however benefit from a series of actions to be undertaken at Mweeloon that will complement the Compensatory Measures of the CMP and help improve the Conservation Status of stony bank habitat at Mweeloon. The Accompanying Measures are detailed in full in Section 3 of the CMP.

Table 3.1 below relates to NPWS questions and requests for clarification (as outlined in the letter dated 3rd August 2021) on stony bank habitats included in the Mweeloon Compensatory Area presented in the CMR. **Table 3.1** also indicates where in this document technical responses to the questions and requests for clarifications are presented.

During consultations with NPWS, requests were made of GHC to commission a technical note on the flood defences (revetment) and coastal processes at Lurgan Island and in Mweeloon Lagoon. The conclusions and recommendations of the technical note are presented in **Table 3.1**. The detail from the technical note is inserted in full at **Section 7.4** of this report *i.e.* Sections 7.4.1 to 7.4.5 inclusive.

During consultations, NPWS also requested GHC to undertake a series of surveys at Tawin west and commission a technical note on coastal erosion and flood risk in the area; responses to address these requests are presented in **Section 11** below.

Table 3.1: NPWS Observations on Topic B and GHC responses

NPWS Observation	Summary Response	Technical Response
It was outlined in the NPWS letter dated 3rd August 2021 that …the on-going issue of shingle removal, which exacerbates destabilisation of the shingle ridge, has not been addressed. Furthermore, preventing shingle removal within the footprint of the proposed area for compensatory measures will not be adequate on its own to protect the habitat or preserve the ecosystem functions it provides as a barrier between the open sea and the lagoon...	It was discussed with NPWS that human shingle removal is not occurring at the Compensatory Area as presented in the CMR (dated April 2019). However, natural accretion and erosion events are ongoing in particular during extreme weather events. During consultation discussions with NPWS, it was outlined by GHC that measures presented in the CMR allow for the management of the habitats and the prevention of future removal of shingle by humans which will contribute to the functioning of the stony bank as a barrier between the sea and the lagoon. This will help to maintain the existing natural processes of erosion and succession and the existing tidal regime in the area, helping achieve the favourable conservation condition. It was also outlined that regulating grazing will reduce over grazing and dunging and, to a lesser extent, poaching of the habitat, all of which will allow the habitat to be enhanced. During consultation discussions, NPWS noted that while the measures proposed in the CMR will be beneficial to other habitats in the area, the stony bank habitat needs to be improved above its current status and concerns were expressed on whether measures at the area in question can provide any further material improvement. It was agreed with NPWS that the area of stony bank habitats at Lurgan Island would be replaced by an alternative area of stony bank habitat more suitable for improvement. The alternative area lies to the west of the original Compensatory Area and is referred to as Tawin West. During consultation meetings, NPWS requested a series of surveys to be undertaken at Tawin West. The key findings of the surveys are presented in **Section 7.2.1**. In addition to the survey work at Tawin West GHC commissioned a technical note of coastal erosion and flood Risk in the area. The technical note is presented in **Section 7.4** below. As a direct result of using an alternative area of stony banks as compensatory habitat, Lurgan Island is no longer required to provide such compensatory habitat. These habitat areas at Mweeloon are however included in the final Compensatory Measures programme. Specifically, as part of the programme, GHC will undertake a series of actions at Mweeloon that will complement the Compensatory Measures and will help improve the Conservation	**Section 7.1.1**

NPWS Observation	Summary Response	Technical Response
	Status of stony bank habitat at Mweeloon. It was also agreed that GHC would undertake annual monitoring of the spatial extent of the stony bank habitat and sea defences at Lurgan Island.	
…Compensatory Measures Plan does not state the nature of the action that will be undertaken to prevent the removal of sediment, only that such prevention will occur…	Once the development is permitted, GHC will repair/ maintain fences and gates along the boundary of the land purchase areas at Mweeloon and Tawin West to prevent trespass. As GHC will own the land, it will put padlocks on external gates and only allow individuals who lease the land for agricultural purposes access to them, thereby preventing any potential for removal of cobbles *etc*. in the future. Information signs will also be erected at selected locations along the site boundaries to inform the public of the objective of the project and warn against trespass and the removal of material from the shore.	N/A
…Secondly, no evidence has yet been provided that this cessation, on its own, will in fact be sufficient to protect the habitat or to preserve the ecosystem functions it provides as a barrier between the open sea and the lagoon…	GHC recognises that the prevention of the removal of sediment on its own will not be sufficient to protect the habitat or to preserve the ecosystem functions it provides as a barrier between the open sea and the lagoon.	**Section 7.1.1**
…By preventing further extraction, the natural accretion processes acting at the site may result in an increase in the total area of Perennial vegetation of stony banks at Tawin that may, in turn, constitute habitat re-creation due to restoration of the natural processes. Such re-creation could be considered to be compensatory in nature. Unfortunately, there is, as yet, no evidence or information	GHC acknowledges that the natural accretion of stony banks could constitute habitat re-creation and intends to monitor this. However, it should be noted that the Compensatory Measures do not provide for habitat re-creation.	N/A

NPWS Observation	Summary Response	Technical Response
provided by the applicant that allows NPWS to come to a clear view as to whether the proposed measures are adequate. NPWS would be happy to discuss with the applicant the nature of the information and analysis required to facilitate this…		
…The Applicant is to be requested to provide information/data and analysis to support its case that the cessation of sediment removal will in itself be sufficient to facilitate habitat re-creation at the site, and to develop any other measures that may be demonstrated to be necessary by that analysis, in order to achieve sufficient compensatory habitat re-creation…	GHC does not purport that the cessation of sediment removal and natural accretion will result in habitat re-creation at the site, nor are the Compensatory Measures designed for habitat re-creation. The main aim of the Compensatory Measures presented in the CMR for stony bank and salt marsh habitat is to improve the favourable conservation condition of the habitats while preventing the human removal of sediment and regulating numbers of stock that graze on it and reduce the length of the annual grazing season. As outlined above, that while the stony bank habitat at Lurgan Island is not counted as part of the compensatory habitat area, GHC will undertake a series of actions at Mweeloon that will complement the Compensatory Measures and will help improve the Conservation Status of stony bank habitat at Mweeloon. It was also agreed that GHC would undertake annual monitoring of the spatial extent of the stony bank habitat and the defences at Lurgan Island will be monitored as part of the final CMP. The development of the Compensatory Measures for the area as presented in the CMR (dated April 2019) has been informed by a series of studies of the proposed compensatory habitat lands, site visits and surveys and examination of the state of these sea defences. The original surveys were carried out in 2017 while more recent surveys were undertaken in the Summer and Autumn of 2021. This included surveys of the extent of salt marsh habitat at Mweeloon, and ground penetrating radar (GPR) survey at the stony bank habitat area at Lurgan Island to ascertain bedrock characteristics in the areas. Detail of the approach to monitoring is provided	**Section 7.1**
...This analysis is to be shared with NPWS for its review, as part of the package of Compensatory Measures…		
…The applicant's monitoring programme is to be expanded to include the monitoring of the accretion of the shingle bar, and its associated vegetation, in order to		

NPWS Observation	Summary Response	Technical Response
determine the success of the measure/s proposed…	in **Section 7.3**. The information and analysis arising from this ongoing monitoring will be shared with NPWS. As outlined above it was recommended by the NPWS that stony bank habitat located to the west of the Mweeloon Compensatory Area be included in the final CMP. Following landowner negotiations and a series of surveys undertaken on behalf of GHC, an area (herein referred to as Tawin West) was selected for inclusion in the CMP.	
…The Compensatory Measures Plan is to be amended to specify exactly what type of action will be taken to ensure this cessation of extraction…	Actions to be implemented to prevent the removal of sediment are summarised above.	**Section 7.1**
…The Compensatory Measures Plan states that only sensitive repairs will be undertaken on the sea wall due to the potential implications for the lagoon habitat if these sea defences were to fall into disrepair. However, such sea defences are likely to be interacting with the natural processes that sustain the stony bank habitat and vegetation…	As outlined above, an alternative area of stony bank habitat at Tawin West is included in the Compensatory Area. It should be noted, however, that annual monitoring of the spatial extent of the stony bank habitat and sea defences at Lurgan Island will also be commissioned by GHC.	n/a
…The CMP is to be amended to include the undertaking of a study of the potential implications for the Annexed habitats of the removal, or maintenance, of the sea defences, with a view to	To address this observation, GHC commissioned a technical note on the flood defences (revetment) and coastal processes at Lurgan Island and in Mweeloon Lagoon and possible future coastal pressures on this site and management of the coastal defences going forward. The conclusion and recommendation of the technical note are presented below while the full technical note is presented in **Section 7.4** below.	**Section 7.1.4**

NPWS Observation	Summary Response	Technical Response
recommending the appropriate course/s of action for achievement of their favourable conservation condition…	The sea defence revetment has failed to achieve its objective of protecting the shingle ridge shoreline behind the defences at the western end of Lurgan Island. The revetment will continue to fail through displacement and lowering as the surrounding shingle is removed under episodes of wave attack. It is not clear as to how much of this shingle bank has been pushed landward or washed seaward, but it is likely that heavier shingle material behind the revetment has been displaced landward towards the lagoon forming a flatter, lower shingle area. There is no evidence of significant erosion at the exposed seaward face of this revetment nor is there evidence of shingle deposition along the face either. It is likely that the shingle is transported around to the north side of Lurgan Island. The revetment is presently acting as a potential barrier to local deposition at this immediate location. The revetment, given its orientation, is only likely to be causing a local impact on sediment transport and there is no evidence that it has impacted on or represents an impact risk to the other sections of the stony bank shoreline at Lurgan Island or along the greater Tawin and Mweeloon shoreline areas. It is recognized that this lagoon system and stony bank shoreline areas needs to be dynamic to compete with the increasing pressures from future sea level rise and increased storminess and that hard engineering solutions are often not the most sustainable solution and can turn from being a friend to being a foe. This revetment is in place for more than 20 years and as such the lagoon has continued to function. In the medium term, this revetment will continue to be lowered and displaced, thereby reducing its effectiveness as a coastal defence barrier. This gradual lowering should facilitate a more natural sediment regime to function behind the defence. Given the current eroded state of the shingle ridge behind the revetment, the sudden removal of this revetment returning it to an unprotected state introduces unacceptable risk to the functioning of Mweeloon Lagoon, with the potential for complete erosion of the shingle barrier if left unprotected. This would allow more exposed wave conditions to enter Mweeloon Lagoon and erode the inner banks of the lagoon and potentially alter tidal flows and sediment regime within the lagoon.	

NPWS Observation	Summary Response	Technical Response
	Given the highly sensitive nature of the Mweeloon Lagoon, the stony bank shoreline and the salt marsh areas, all of which are qualifying interests of the Galway Bay SAC, decisions as to the appropriate management measures for the coastal defences at Lurgan Island require very careful consideration, backed by scientific understanding and analysis. The decision as to whether the defences should be retained, maintained, strengthened, lowered, replaced or removed altogether cannot be determined at this point as it requires considerable further studies over many years so as to ensure scientific certainty as to the potential impact on the SAC of such measures. It is therefore strongly recommended that no works to the sea defences be carried out at the present time, leaving them to their natural evolution, until a fuller scientific understanding of the implications of the management options on the site can be established. Subject to the grant of planning permission such management and monitoring studies which will involve longer-term assessment and monitoring will be included as part of the commitments in the Compensatory Measures Plan. The future research and monitoring of the shingle bar at Lurgan Island and Mweeloon Lagoon will be carried out by a multidisciplinary team that includes within the team a coastal geomorphologist. These future assessment and monitoring studies will involve regular detailed shoreline topographical surveys and bathymetric surveys, possibly utilising the current baseline survey transects, for comparison purposes, photographic surveys of the causeway erosion control armoured block (ECAB) units and ongoing monitoring of level and displacement of these units, detailed hydrodynamic and sediment transport modelling studies of the local and wider area, sediment sampling and distribution analysis, storm event analysis and the possible seeding of tracer sediments to identify and track movement of the shingle. Long-term tide level monitoring will be conducted involving the installation of water level recorders, one, within the Mweeloon Lagoon, a second in the southern lagoonal area south of the Tawin causeway road and a third in the open sea near Mweeloon Bay.	

4. Topic C - Reef and Mud and Sand Flats

Table 4.1: NPWS Observations on Topic C and GHC responses.

NPWS Observation	Summary Response	Technical Response
It was outlined in the NPWS letter dated 3rd August 2021 that …The objectives of the conservation measures remain vague with respect to marine habitats; these must be further developed to ensure they can be adequately measured and tracked over time…	For marine habitats, the Compensatory Measures have been developed for 3 individual and separate targets species/areas, namely: **1.** The control of the non-native, invasive tunicate *Didemnum* that is fouling oyster farms in Mweeloon, **2.** The fallowing of parts of Mweeloon Bay that are used for oyster cultivation and will include the cessation of tractor and trailer traffic to and from the farm and **3.** The implementation of "nature friendly[3]" farming practices that besides having beneficial effect on terrestrial habitats, may also have beneficial effect on intertidal marine ecology. Methods by which the success of the Compensatory Measures can be assessed have been identified and described in detail in **Section 8.1**. Clear and specific objectives for each aspect of the marine monitoring plan are identified and measurable outcomes on which the success or otherwise of these measures will be ascertained. Both indicators and thresholds for each target have been established. Clear and specific objectives for each aspect of the marine monitoring plan are identified and measurable outcomes on which the success or otherwise of these measures will be ascertained. Both indicators and thresholds for each target have been established.	**Section 8.1**

[3] Farming practices appropriate to the Conservation Objectives of the Galway Bay Complex SAC.

NPWS Observation	Summary Response	Technical Response
	During consultation discussions, NPWS queried the *Didemnum* treatment and whether the treatment will continue after the structures are removed. It was confirmed to NPWS that the measures to be employed as part of the CMP to control the invasive tunicate *Didemnum* will evolve depending on results *etc* and that the efficacy of the treatment will be checked shortly after use and repeated if necessary to ensure a satisfactory control is achieved.	
… It is also unclear how they can be implemented in an area of foreshore that would not be in the ownership of the proponents, and for which other potential users may come forward in due course…	GHC has acquired and extended the options for the purchase of the control of two aquaculture licences within the Compensatory Area (Site ref: T09/376B, T09/377A). Once the development is permitted, the intertidal areas of the licensed sites T09/376B and T09/377A will be cleared of all aquaculture structures and they will be preserved free from aquaculture activities. This leaving fallow parts of the intertidal habitat that are currently being used to farm oysters will allow the removal of pressures associated with operating the farms. In the future, GHC will object to further licencing of activities within the Compensatory Area.	**Section 8.1**
…The objectives for the conservation measures for these habitats are to be further developed in an iterative manner, in line with their conservation objectives, and associated attributes and targets, in Galway Bay Complex SAC, as the compensatory measures are implemented…	The main aim of the compensatory plan for Reef and Mud and Sand Flats is to reduce or remove the pressures acting on the habitats that may be adversely affecting the conservation condition of the habitats. As outlined above the Compensatory Measures have been developed for 1) the control of the non-native tunicate species *Didemnum* in Mweeloon, 2) removing pressures associated with oyster cultivation acting on area within the compensatory area and 3) the implementation of "nature friendly" farming practices that may have beneficial effect on intertidal marine ecology. **Section 8.1** describes the methods by which the success of the Compensatory Measures will be assessed.	**Section 8.1**

5. Topic D - Atlantic Salt Meadows (*Glauco-Puccinellietalia maritimae*)

Table 5.1: NPWS Observations on Topic D and GHC responses.

NPWS Key Message	Summary Response	Technical Response
…Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*): Grazing during the summer months reduces the wider ecological benefits provided by coastal habitats (specifically relating to bird breeding and pollination) and therefore, does not improve the overall coherence of the Natura 2000 network. Modification required: - Summer grazing is not to occur; it is to be replaced with winter grazing and the monitoring programme amended accordingly…	Following discussions with NPWS it was agreed that Atlantic Salt Meadows could be included as part of the Accompanying Measures as part the CMP. Following extensive consultation and discussions with the current owners and lessees of the lands at Mweeloon implementation of light grazing regime between the May 1st and the October 31st, will be followed. Grazing during these months will be closely monitored. At Tawin West Compensatory Measures will be set in place to regulate grazing to reduce overgrazing and dunging and to a lesser extent, poaching of the habitat. There will be no grazing between the April 1st and the August 31st. A light grazing regime will be implemented between the September 1st and the March 31st at a grazing intensity of between 0.5 to 1.0 LU per hectare. As the areas at Mweeloon and Tawin West will be subject to different grazing regimes, the results of the vegetation monitoring will provide important comparative (reference) information regarding the ecological management of vegetation in salt marsh and stony bank areas.	**Section 9**

6. Topic E - Long Term Management of the Site

Table 6.1: NPWS Observations on Topic E and GHC responses.

NPWS Key Message	Summary Response	Technical Response
… NPWS would also welcome a role in reviewing the reports submitted and in the making of recommendations to the planning authority and the proponent on improvements or modifications that may be made to the management measures, in order to ensure the coherence of the Natura network, and the achievement of conservation objectives.…	Annual Reports on the Implementation of the Compensatory Measures Plan will be prepared and submitted to the Planning Authority and to NPWS/ DHLGH. The Annual Report will include a section describing monitoring activities, results and any recommendations arising for the adaptation of the Compensatory Measures, in view of the monitoring results. Annual Meetings with the Planning Authority and NPWS/DHLGH will be convened to discuss the Annual Reports and any modifications/ adaptations that are recommended, for their approval. If matters of significance arise in the intervening months that may warrant more immediate amendment of a compensatory measure, approval of same will be sought by correspondence or by an extraordinary meeting, the latter on request. **Compensatory Measures Plan Implementation** It is expected that the implementation of the CMP will be overseen by Galway City Council ("GCC") as the planning authority for the Galway Harbour Extension The envisaged implementation approach is that an annual report will be prepared by Galway Harbour Company ("GHC") and their specialist team in relation to the monitoring and management of the compensatory measures areas, adjacent areas of accompanying measures and additional environmental benefits, all in line with the CMP. This annual report will be submitted to GCC. The planning authority (GCC) is expected to determine the methodology and procedures for implementation, including the circulation of the annual report to the relevant stakeholders, one of which will be NPWS, and perhaps Galway County Council and others as GCC consider appropriate.	N/A

NPWS Key Message	Summary Response	Technical Response
	It is envisaged that the implementation will include an annual meeting of all of the stakeholders, including GHC, and will allow for more frequent meetings if required. The implementation is expected to include site visits at appropriate seasonal times by the relevant stakeholders. For example, there may be a site visits in early Spring and again in September before and after the appropriate growing seasons on the lands. The annual report will then be submitted to GCC before the year end in order to allow time for GCC, NPWS and other relevant stakeholders to review the findings and make recommendations as required ahead of the next spring season.	

7. Technical Responses - Topic B

7.1. Cobble Removal and Accumulation

Stony bank habitat at the Mweeloon Compensatory Area is present all along the northern shore from Tawin Island, through Lurgan Island and as far as the eastern limit of the Compensatory Area. During the course of *circa* 4 years of field work in the proposed Mweeloon compensatory area, on no occasion was any person seen removing such material from the site nor were any signs *i.e.* tracks, ruts, noted along the shore or through fields to reach the shoreline of access by tractor and trailer. It is considered therefore that such activities have not taken place over that time period in that area of Tawin Headland. Drs. John Brophy and Jim Martin of BEC (Botanical Environmental Consultants) who carried out National surveys of stony bank and salt marsh habitat in Ireland (including Tawin) for NPWS in 2017 were contacted and the only place where they observed removal of cobbles *etc.* was in the southeastern corner of Tawin Island. Given this, it therefore implies that natural removal, and to some extent, accretion of cobble *etc.* is taking place but that this only occurs in extreme storm events (coinciding with High Water Spring tides) such as Storm Darwin in October 2014 and Storm Ophelia in February 2017. Cobbles thrown up from the sea at Renmore Lagoon are shown in **Figure 7-1**. During extreme storm events, extensive volumes of cobble/gravel are piled up on the shoreline by breaking waves and when these waves recede, they draw down finer gravel and sands into the upper shore areas.

Figure 7-1: Cobbles thrown up from the sea at Renmore Lagoon after Storm Ophelia, 2017.

Less severe events, such as Storm Emma February/March 2018, Desmond, November/December 2015 and Storm Ali, September 2018, also contribute to the dynamic nature of physical processes that affect stony bank habitats and coastal defence works.

A precast concrete sea defence block revetment (see **Figure 7-2**, **Figure 7-3** and **Figure 7-4**) was put in place at the south western end of Lurgan Island, more than 20 years ago. As part of the on-going studies of the area, site visits and surveys are being carried out in relation to examining these sea defences. The original surveys were carried out in 2017 and the recent surveys were undertaken in the Summer and Autumn of 2021.

The recent surveys and studies on the toe, the angle of the blocks and the crest are showing significant slippage of the top lines of concrete blocks which were constructed as part of the existing sea defences.

Figure 7-2: Erosion behind sea defence blocks, Lurgan Island, October 2021.

Figure 7-3: Destabilisation of sea defence blocks, Lurgan Island, October 2021.

Figure 7-4: Flattening out of top layer of sea defence blocks, Lurgan Island, October 2021.

This slippage is resulting in the top lines of the sea defences moving to a flat position rather than angled as per the original construction as the materials including cobbles and sediments behind the existing sea defences are being washed out. Aerial images indicate considerable erosion of land and the width of the shingle bars between 2009 and 2020. There is some concern in that regard given the significance of the lagoon which is currently being protected by way of the sea defences and erosion occurring within the lagoon as a consequence of greater overtopping of reducing the height of defences.

There are signs of erosion in this area and along the northern coastline of Lurgan Island itself and further along the shoreline towards the east. Google images 2009 to 2020 indicate erosion of adjacent headlands to the north which allows increased erosion to these areas.

The area will be surveyed annually and also after significant storm events as outlined in above and when required, monitoring will be carried out.

GHC has entered into binding agreements to purchase outright separate land holdings within both the Mweeloon Compensatory Area (and the Tawin West Compensatory Area) (see **Figure 7-5**). Blake and Kenny Solicitors confirmation regarding the new Land Purchase Agreement (Tawin West) is included in Appendix D. Once the development is permitted GHC will repair/ maintain fences and gates along the boundary of the land purchase areas to prevent trespass. As GHC will own the land, it will put padlocks on external gates and only allow individuals who lease the land for agricultural purposes access to them, thereby preventing any potential for removal of cobbles *etc.* in the future. Information signs will also be erected at selected locations along the site boundaries to inform the public of the objective of the project and warn against trespass and the removal of material from the shore. Lands to the east and west of the Mweeloon Compensatory Area are in private ownership. Access across these lands to the stony bank habitat in the east of the Study Area is prohibited.

The locally rare plant species yellow-horned poppy (*Glaucium flavum*) grows along this stretch of shingle bank. Preventing the removal of shingle/cobble will contribute to the continued presence of the species at this location.

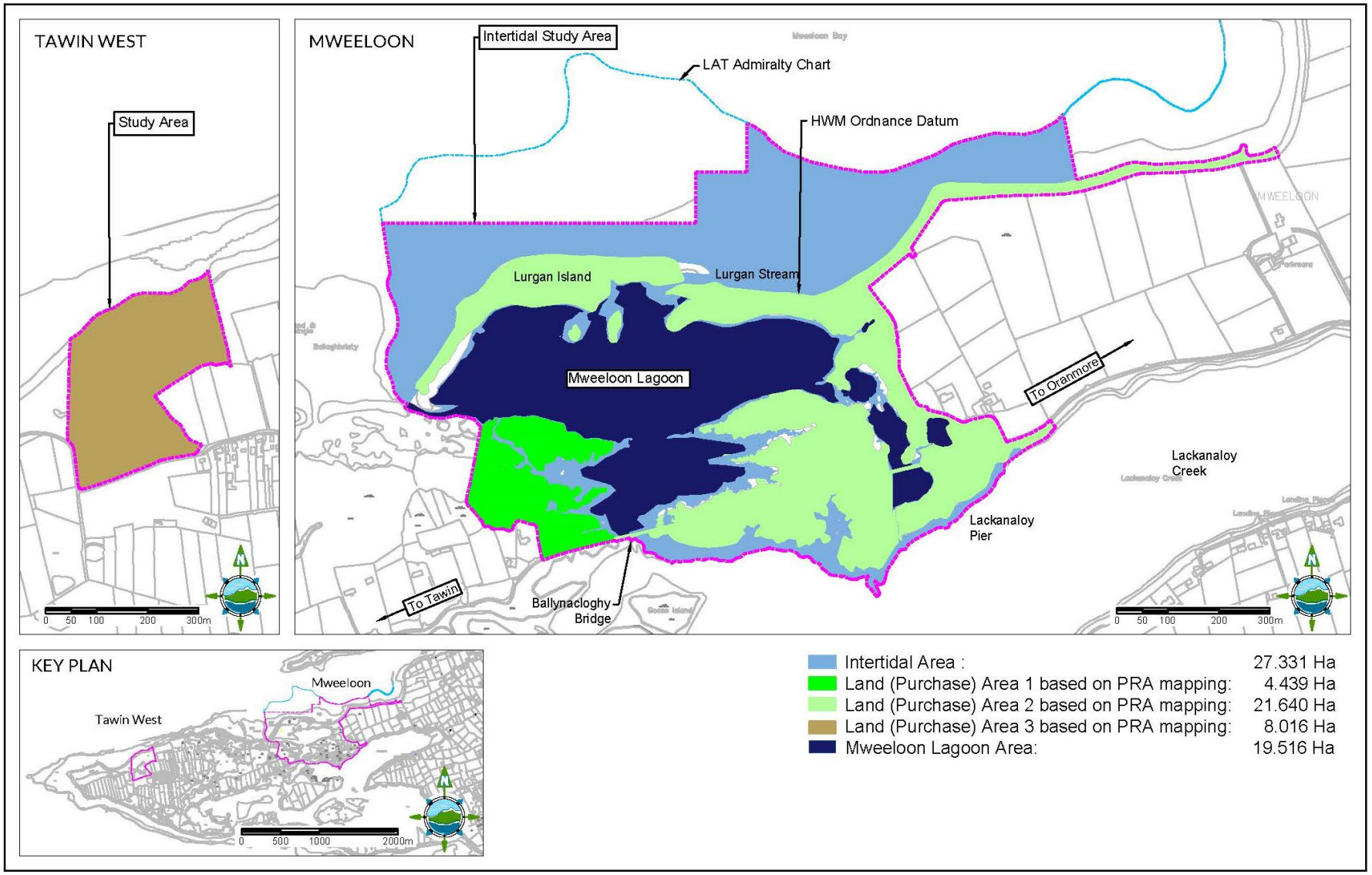


Figure 7-5: Land Purchase Areas.

7.2. Stony Bank and Salt Marsh Habitat

7.2.1. Overview

In the CMR a suite of Compensatory Measures was established for stony bank and salt marsh habitat at the Mweeloon Compensatory Area.

The habitats within the Mweeloon Compensatory Area and the Tawin West Compensatory Area are shown in **Figure 1-1**.

Following consultation with the NPWS, it was agreed that the stony bank at Mweeloon should not form part of the compensatory habitats but could be included as part of the Accompanying measures . For the stony bank and salt marsh habitat at Mweeloon, a series of actions are identified in the CMP. The actions, which complement the measures programme, will help improve the habitat types at Mweeloon and address the historic loss of these habitats types due to the development of the GHEP in the mid-1990s.

7.2.2. Stony Bank

With regard the stony bank, the NPWS recommended that an alternative area of stony bank habitat which was more degraded and thus more suitable for inclusion in the CMP was identified at Tawin West (to the west of the Mweeloon Compensatory Area). The Compensatory Measures proposed for the stony bank Habitat at Tawin West, which are presented in detail in Section 2 of the CMP, are summarised in **Section 10** below.

While the NPWS indicated that the stony bank habitat at Mweeloon should not form part of the Compensatory habitats, it was agreed that the habitat could be included as part of the measures programme. Specifically, for the stony bank habitat at Mweeloon GHC will undertake a series of actions that will complement the Compensatory Measures programme. The actions, which are referred to as Accompanying Measures in the CMP, will help improve the Conservation Status of the stony bank habitat at Mweeloon. The Accompanying Measures for stony bank habitat are presented in full in Section 3 of the CMP.

7.2.3. Salt Marsh

In the CMR, the salt marsh habitat at Mweeloon was presented for historic impacts arising from the development of GHEP. It was agreed with the NPWS that the salt marsh habitat should not form part of the compensatory habitats but could be included as part of the Accompanying measures. As is the case for stony bank habitat at Mweeloon, a series of Accompanying Measures will be set in place that will complement the Compensatory Measures programme and will help improve the Conservation Status of salt marsh habitat at Mweeloon. The Accompanying Measures for salt marsh habitat are presented in full in Section 3 of the CMP.

Table 7.1: Conservation Objective and targets for habitat 1220 Perennial vegetation on stony banks in the Galway Bay Complex SAC (NPWS 2013).

Attribute	Measure	Target	Positive effect of Accompanying Measures
Habitat area	Hectares	Area stable or increasing, subject to natural processes, including erosion and succession	Yes. Prevention of removal of sediment at Lurgan Island and nearby areas will help control for potential loss of habitat.
Habitat distribution	Occurrence	No decline, or change in habitat distribution, subject to natural processes.	Yes. Prevention of removal of sediment at Lurgan Island and nearby areas will help control for potential loss of habitat.
Physical structure: functionality and sediment supply	Presence/ absence of physical barriers	Maintain the natural circulation of sediment and organic matter, without any physical obstructions	Yes. Prevention of removal of sediment at Lurgan Island and nearby areas will contribute towards the maintenance of the stony bank as a barrier between the sea and the lagoon, helping to maintain the natural circulation of sediment and organic matter.
Vegetation structure: zonation	Occurrence	Maintain range of coastal habitats including transitional zones, subject to natural processes including erosion and succession	Yes. Prevention of removal of sediment at Lurgan Island and nearby areas will contribute towards the maintenance of the stony bank and existing tidal water regime and thus vegetation zonation. The control of grazing will reduce the likelihood of over-grazing and nutrient-enrichment and thus maintain vegetation structure.

Attribute	Measure	Target	Positive effect of Accompanying Measures
Vegetation composition: typical species and subcommunities	Percentage cover at a representative sample of monitoring stops	Maintain the typical vegetated shingle flora including the range of subcommunities within the different zones	Yes. Prevention of removal of sediment at Lurgan Island and nearby areas will help to maintain the existing vegetation communities. At Tawin West here will be no grazing allowed between the 1st of April and the 31st of August and a light grazing regime will be implemented between the 1st of September and the 31st of March at grazing intensity of between 0.5 to 1.0 LU per hectare. These measures will promote the flowering and growth of plant species which will in turn a range of insect species. At Mweeloon the comparative reference regime will be a light grazing between the 1st of May and the 31st of October and the lands will then be rested until the next season.
Vegetation composition: negative indicator species	Percentage cover	Negative indicator species (including non-natives) to represent less than 5% cover	Annual survey to be undertaken will monitor vegetation composition. Should a high cover of negative plant species be identified GHC will assess means of control of the species and address the cause driving the increase.

7.3. Monitoring Stony Bank and Salt Marsh

The monitoring of Mweeloon salt marsh and stony bank vegetation and Renmore salt marsh and stony bank vegetation will be monitored using the survey techniques specifically developed by the National Parks and Wildlife Service for the monitoring of salt marsh and stony bank vegetation, see McCorry and Ryle (2009) and Martin *et al.* (2017).

Central to this monitoring will be the establishment of a large number of monitoring points which can be revisited at regular intervals in order to document any changes in vegetation composition and structure which result from the different management practices employed.

It is proposed that five quadrats will be established within each hectare of salt marsh and stony bank habitat. This will give a total of 80 monitoring quadrats at Mweeloon (60 in salt marsh habitat and 20 in stony bank habitat) and 10 quadrats in stony bank habitat at Renmore. A total of 32 monitoring quadrats will be established at Tawin West (20 in salt marsh habitat and 12 in stony bank habitat). Quadrats will be surveyed twice a year, at the beginning of the growing season, *i.e.* May and close to the end of the growing season*, i.e.* late July/early August. Vegetation composition and structure will be surveyed within 2x2 metre quadrats.

In each quadrat the following parameters will be recorded:

1. Size.
2. Grid reference, as documented by GPS. This will aid in the relocation of quadrats during subsequent monitoring surveys.
3. Percentage cover of vegetation, bare soil, water and rock.
4. Percentage cover of vascular plant and bryophyte species present.
5. Degree of flowering observed with respect to each vascular plant species.
6. Percentage cover and height of the different vegetation layers, *i.e.* shrub, herb and bryophyte.
7. Height of vegetation.
8. Soil type and depth.
9. Slope and aspect.
10. Additional details, such as the composition of the surrounding vegetation, degree of grazing/habitat disturbance *etc*.

A photograph of each monitoring quadrat will be taken during each survey in order to document the appearance and condition of the habitat.

The information and analysis arising from this ongoing monitoring will be shared with NPWS.

Stony bank monitoring

Important monitoring goals for stony bank vegetation/habitat include:

1. Maintain a low cover of non-native or weedy species in the vegetation, *i.e.* <5% cover in monitoring quadrats. In the case of stony bank habitat the monitoring of the cover of weedy and non-native species, *e.g. Senecio jacobea*, *Lolium perenne*, *Cirsium arvense* and *Lactuca tatarica*, is of particular interest as the presence of these species indicate a degree of disturbance and enrichment of the habitat. The presence of the alien species *Lactuca tatarica* at Renmore has been previously noted and recent observations show that the species has a high cover in places.
2. Ensure a low incidence of disturbance due to trampling and grazing of stony bank vegetation by livestock. This can be measured by noting parameters such as vegetation height, presence of bare soil *etc*. within monitoring quadrats.
3. Promote improved flowering/seeding of stony bank vegetation. This will be achieved by implementing an appropriate, low-intensity grazing regime.

Salt Marsh monitoring

Salt marsh monitoring points at Mweeloon and Tawin West will be positioned along transects which will sample the natural variation in the Atlantic salt marsh vegetation which occurs ranging from upper marsh to lower marsh. Important monitoring goals for salt marsh vegetation/habitat include:

1. The maintenance of site specific structural variation in the sward.
2. The presence of characteristic plant species of the various salt marsh zones.
3. Ensure that less than 5% cover of bare soil due to livestock poaching is achieved.
4. Promote improved flowering/seed production of salt marsh vegetation. This will be achieved by implementing an appropriate, low-intensity, grazing regime.
5. Monitor for the presence of the invasive Cordgrasses (*Spartina* species). It should be noted however that these invasive grass species have not yet been recorded from the Inner Galway Bay area.

7.4. Technical Note on the Flood Defences and Coastal Processes at Lurgan Island and in Mweeloon Lagoon

7.4.1. Introduction

The Mweeloon Compensatory Area is located along the southern shoreline area of Mweeloon Bay and the Mweeloon Lagoonal area south of Lurgan Island. These lands form part of the larger peninsula area that extend westward into Galway Bay with Tawin Island and Kilcolgan Point being the most exposed westerly part, taking the brunt of Atlantic and local wind wave storms that propagate inshore from the Southwest, West and Northwest. The source of sediment material that is present, as shingle on the stony shore and as sands, gravels and muds within the lagoonal area is from the erosion of sites locally and on the exposed west and northwest shoreline of Tawin Island. Eroded material is generally moved eastward under wave action depositing in the more sheltered northerly and northeasterly facing shoreline areas. The northwestern facing shoreline areas are more exposed and under attack from wave action and show evidence of retreat along the northern shoreline area at Tawin and Mweeloon.

Lurgan Island is one of the barrier islands that surrounds Tawin Island. This shingle ridge at the western end of the island that shelters the lagoon is migrating landward (southeast) under coastal erosion and in the process, the ridge is reducing in elevation. It is clear from historical OSI 25inch mapping for the area (OSI first edition *circa.* 1888) that the shingle ridge has migrated southeast by *circa.* 10 to 15m and has significantly narrowed. The ridge has moderate exposure to wave climate with extreme waves of 1.5 to 2m expected particularly if coinciding with highwater springs. Under such extreme conditions, this shingle ridge is naturally overtopped which accelerates the retreat of the bank.

A general location map of the main features at the Mweeloon Lagoonal Site referenced in this report is presented in **Figure 7-6**.

Sections **7.4.2 to 7.4.5** prepared by Mr. Anthony Cawley, Hydro Environmental Ltd (10th January 2022) present a technical note on the flood defences and coastal processes at Lurgan Island and in Mweeloon Lagoon and possible future coastal pressures on this site and management of the coastal defences going forward.

7.4.2. Lurgan Island Coastal Defence

Coastal defences were deemed required in the early 1990's and were progressed towards the end of the 1990's to protect a long narrow shingle ridge which is a spit like feature at the southwestern end of Lurgan Island that was being eroded by wave action after a series of northwesterly storms. The coastal defences comprise sections of natural rock armour stone (2 tonne limestone armour stone) at the two ends of a defended section of engineered revetment that consisted of a proprietary erosion control armoured block (ECAB) system of interlocking concrete block units. The coastal defence was installed to protect and reinforce the eroding narrow elevated shingle ridge at the southwestern end of Lurgan Island as it was considered that the loss of this ridge would expose the surrounding lands and public road to erosion.

It is likely that the coastal protection may have been in response to previous storms and possibly to storm damage in 1990 /1991 from northerly/ northwesterly winds combining with spring tides and more damage is likely to have occurred from the January 1995 event which involved westerly storm winds, an Atlantic surge and Spring tides.

It is understood based on Dáil record of proceedings on the 3rd February 1994 that the coastal defence was required to prevent erosion of the local road to Tawin Island which is located along the south boundary of Mweeloon Lagoon. Funding was made available for the coastal protection works at Lurgan Island to protect the headland in the event it would be lost to the sea. It was believed that such loss of the headland at Lurgan would expose the inner lagoonal area and the causeway road and bridge to Tawin Island to greater flooding impact and to storm waves and much increased flow through the bridge

into the larger lagoon to the south of the road. It is considered that the loss of the shingle barrier at Lurgan would generate more local wave action within Mweeloon Lagoon and particularly along the eastern and southeastern shoreline which would erode into the permanent grass bank surrounding the lagoon. The loss of this spit could potentially open the lagoon to being an intertidal bay area, with the potential for greater intertidal flows discharging southwards via the Ballynacloghy Bridge (marked 2 in **Figure 7-6**) and for greater penetration of sea waves into the lagoon.

Plate 1 presents a photo of the revetment at completion with local shingle cobbles locally won placed as a capping layer. Plate 2 presents a view of the revetment which was likely to have been taken a number of years after construction sometime in the mid 2000's. This coastal protection extended along the exposed northwesterly facing shoreline for *circa.* 200m with the *circa.* 125m protected by the ECAB revetment and *circa.* 75m by rock armour. The original crest height of the top of the revetment was set at *circa.* 4.2 mOD. The ECAB system is designed through its interlocking blocks with hollow sections to provide for wave energy dissipation, so as to reduce erosive energy and wave reflection.

The ECAB is octagonal in shape and has recesses and projections on opposite sides of the unit to allow adjacent blocks to interlock. The blocks are placed in a honeycomb pattern at a slope of 1 in 2 or flatter. An underling filter material is often required to prevent wash out through the voids in the unit. In the case of Lurgan, the coarse shingle from the beach was used as the filter layer. The units and placement pattern provides almost 40% porosity that assists in dissipation of wave energy and reduction in wave reflection coefficient to between 0.2 and 0.5 based on physical model tests. Expected wave run-up is 3 to 1 (*i.e.* 3m runup for a 1m wave height). It is understood that the Lurgan site was a test site for ECAB. The photo at the end of construction presented in Plate 1 shows that the voids were back filled with the local shingle, to act as "grass blocks" which they initially did, as per Plate 2. The effect of this filling caused the actual porosity available for wave energy dissipation to be reduced. Plate 2 taken a number of years later shows, at the lower levels, that much of the shingle material from the interlocking voids has been removed by wave action.

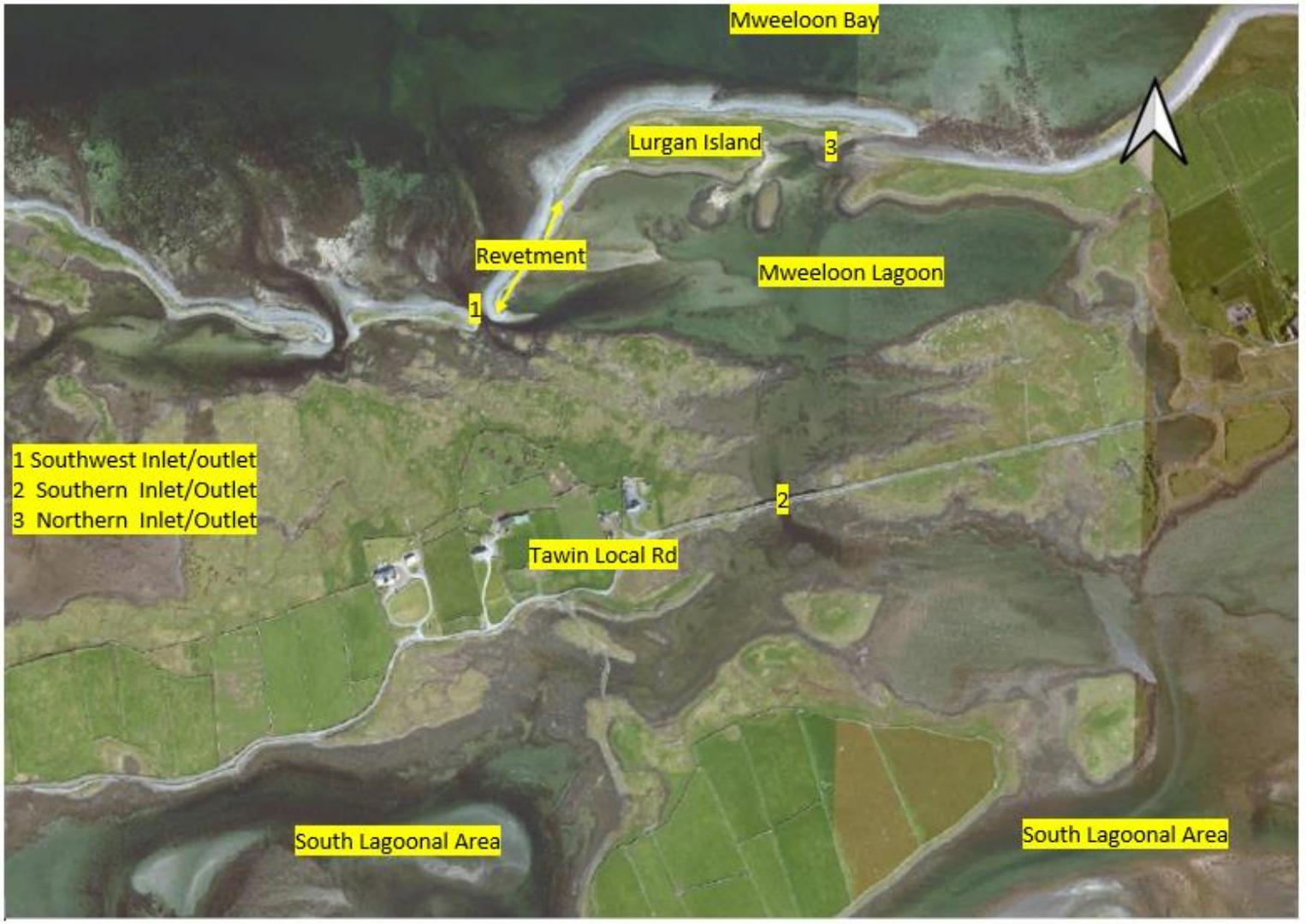


Figure 7-6: General Description of Mweeloon Site on the Tawin Headland.

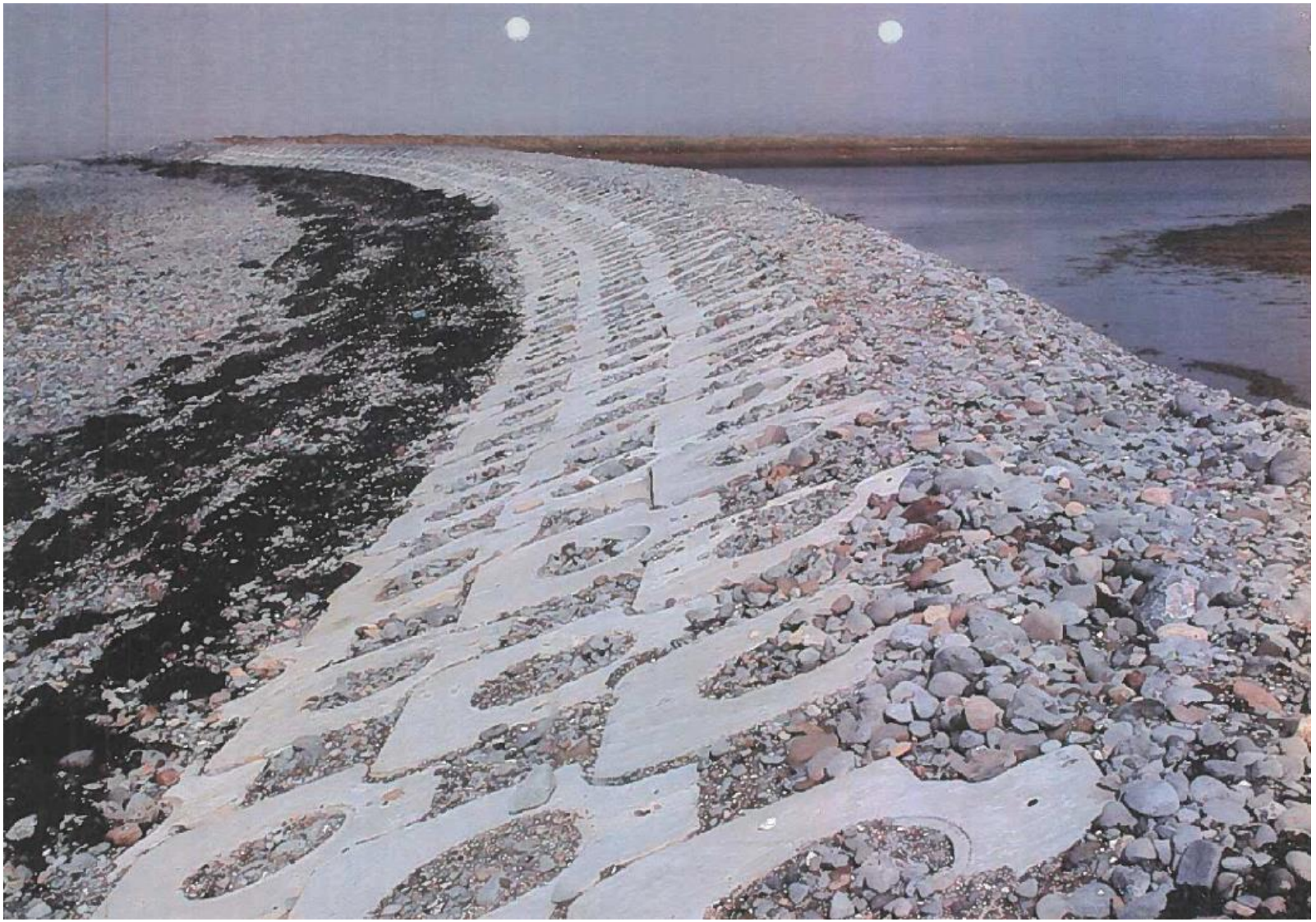


Plate 1. Revetment at completion date with locally won shingle material at the back of the revetment.

Plate 2. View of interlocking concrete block revetment at Lurgan Island (extract from ECPS Ltd. Ecab.ie).

Plate 3. Drone Photo (flown in 2017) of coastal defences and shallow sand intertidal lagoon area behind defences at Lurgan Island

7.4.3. Present-day State of Revetment

The lowest section of the revetment where most damage and displacement has occurred is located midway along the revetment. A topographical survey by TOBIN for this section shows that the top of block level is now at *circa* 3.5m OD Malin (originally at 4.2mOD) and the top of the shingle level behind these blocks is at *circa* 2.5 to 2.8m OD (see **Appendix C**). This represents a drop in block level of *circa* 0.7m and lowering of the shingle material behind the defences by some 1.4m. Its smooth interlocked concrete face, particularly when the voids are filled with shingle, facilitates wave runup to shoot over the top of the revetment at high velocities, thus easily eroding and lowering the shingle bank behind the revetment. The shingle material behind the armour blocks has been significantly eroded with the majority of the material scattered southeast towards the lagoon. Sand and shingle material under and surrounding the armour blocks has been eroded causing substantial lowering of the upper blocks with many now flat and displaced and no longer fully interlocking (top 2 layers of blocks, refer to Plate 4). This dramatically reduces their effectiveness as a defence and allows for further undermining of material. This interlocking block once displaced provides limited protection, as strength comes primarily from the interlocking mass as opposed to the individual units. The octagonal shape of the armour block with recesses and projections on alternate sides when displaced allows for confined channels that assist the explosive removal of shingle material surrounding and beneath these blocks on impact by the breaking waves. A lot of the finer sands within the shingle is likely to be carried in the back wash out to sea as well as into the lagoon.

At present the defence functions more as a breakwater, as opposed to a shoreline protection, causing waves to break, runup and overtop into the lagoon. However, the reduction in height of the revetment has reduced the overall effectiveness against waves, particularly when coinciding with highwater springs and, as such, will continue to be undermined with the shingle material washed out and the ECAB units becoming more displaced and lowered. It is likely that this process will continue for some time to come, many years, before becoming completely ineffective even as a coastal breakwater.

It is likely that sediments in calmer conditions are deposited along the toe of the revetment, and then eroded in more stormy weather, such that this revetment, thereby, currently acts as a barrier to the natural episodes of shingle deposition onto the shoreline behind these defences. Based on the orientation and geology of the site, it is unlikely that these coastal defences are impacting sediment transport elsewhere along shoreline at Lurgan Island and in Mweeloon Bay.

The ECAB revetment protection may have worked more successfully as a shoreline defence had a better understanding of the exposure of the site and the elevation of the storm surge highwater level had been acquired. It is considered, based on inspection, that the revetment height was not sufficient to prevent wave run-up and overtopping and, more critically, no top-cap armour block layer and suitably sized capping layer of rip-rap rock armour stone was provided to seal and maintain the interlock matrix, given its location in a moderate to high exposure to the sea waves. The capping material used at the crest of the revetment is generally sand and small cobbles and provides little resistive function once overtopped (refer to Plate 1). This shingle capping has been completely eroded and removed with the ECAB top two block layers completely exposed and many units displaced.

Plate 4. Lowered and displaced section of ECAD revetment at Lurgan Island (November 2021).

Plate 5. Photos of revetment taken in November 2021 showing substantial undermining of the revetment armour blocks and erosion of the headland behind the defences.

It is likely that the revetment appeared to work well for some time during a benign period in respect to coastal flooding, until the first of a series of significant storm events, commencing in December 2013 that saw major coastal damage along west coast of Ireland. The following are the main storms that have impacted Galway Bay in more recent years, causing coastal erosion and flooding.

- December 2013 (surge tide and wind waves)
- January 2014 (combined tide, fluvial and wave overtopping event)
- December 2015 Tide and wind wave event
- October 2017 Storm Ophelia (tide and waves)
- January 2018 Storm Eleanor (Storm surge and westerly winds)
- October 2018 Storm Callum (tidal surge)
- December 2019 Storm Elsa Surge tide and wave overtopping

These 7 storm events are likely to have resulted in the some 800mm subsidence of the revetment crest level as now recorded.

7.4.4. Coastal Processes

The bedrock geology of this area is a highly weathered Limestone bedrock which is part of the Burren Limestone formation, which is a pale grey, clean, well bedded limestone. The overburden is relatively shallow and generally consists of marine sands and limestone tills. This bedrock material is only moderately resistive due to the naturally high weathering of pure limestones and is erodible under repeated wave action. The limestone bedrock is exposed along much of the lower foreshore. The inlet sills to the Mweeloon Lagoon at Lurgan Island would appear to be set by the sediment/shingle layer, whereas the southern inlet at Ballynacloghy Bridge is set by the limestone bedrock level, which from inspection is founded on exposed limestone bedrock.

7.4.4.1. Geology

The Astronomical Tide and coastal flood levels for Inner Galway Bay are summarized as follows all levels to OD Malin:

- Maximum Recorded HW flood level (HMAX) 3.78m OD
- Annual Median Flood level (H2) 3.08m OD
- Highest Astronomical Tide (HAT) 2.895m OD
- Mean Highwater Springs (MHWS) 2.142mOD
- Mean Highwater Neaps (MHWN) 1.042mOD
- Mean Sea level (MSL) 0.042mOD
- Mean Low Water Neaps(MHLN) -0.958mOD
- Mean Low Water Springs (MLWS) -2.035mOD
- Lowest Astronomical Tide (LAT) -2.967m OD

The tidal gauge at Oranmore Bridge (29015) reflects the high tide water levels at Tawin and Mweeloon. The annual maximum highwater series was extracted from the record, refer to **Figure 7-7**. This series shows that 8 annual maximum tidal events out of 40 exceeded 3.3m OD Malin and 5 events exceeded 3.4m OD which represents a still water level at or above the current crest level of the revetment, without any additional wave action. The highest tide reached 3.795m OD on the 2nd of January 2018 and at this level would have completely submerged much of the revetment. Compounding this 2018 coastal event was locally strong westerly winds that locally coincided with the storm surge at the highwater period and consequently would have generated considerable wave attach at the revetment.

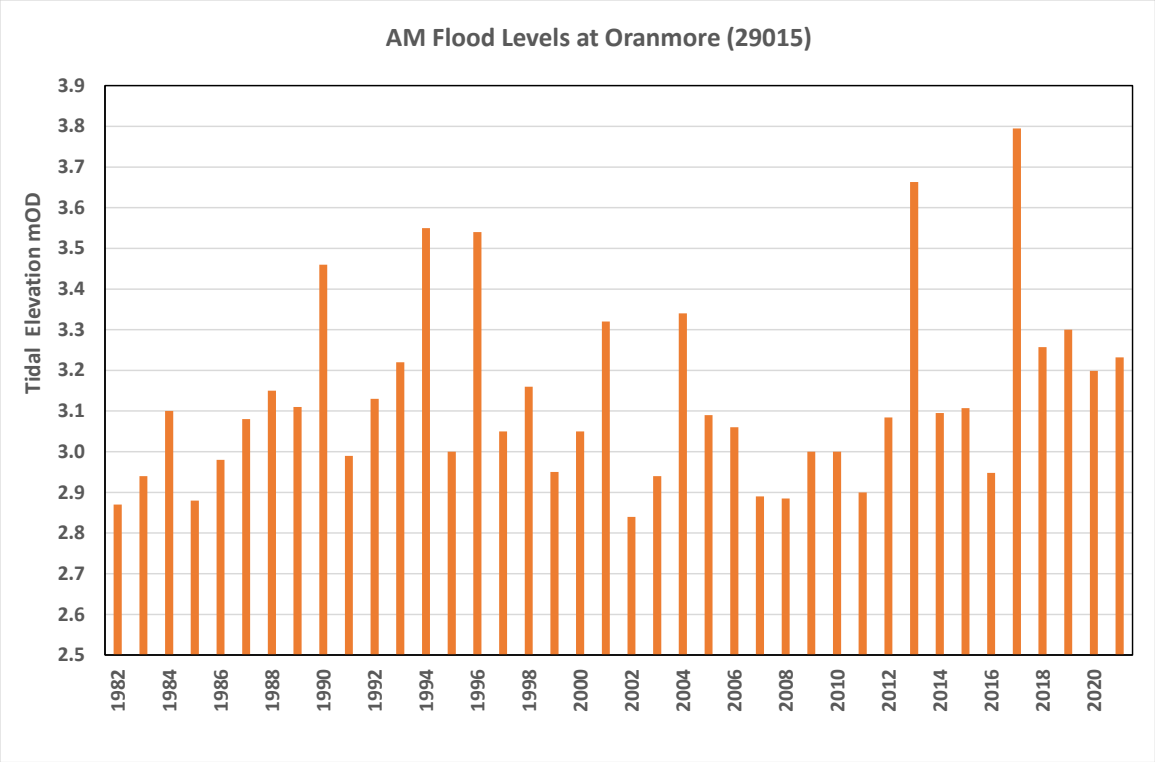


Figure 7-7: Recorded Annual Maximum Flood Level Series at Oranmore Bridge Gauge (20015) from 1982 to 2021

7.4.4.2. Bathymetry

The bathymetric contours just off Tawin Island are 5m below LAT at *circa* 500m and increasing to 10m at *circa* 1km from Kilcolgan Point on Tawin Island. This bed profile enables reasonably large Atlantic waves to reach the shoreline waters off Tawin Island. The westerly propagating waves can diffract around Tawin headland, entering Mweeloon Bay, and changing direction to a more acute southeast direction as they break on the intertidal shoreline areas at Ballaghbristy and Creggauns and the permanent shoreline area along the north shore of Tawin, Creggauns and Lurgan Island. Depending on the timing of the wave event with the tide and particularly, when it coincides with highwater, increases the damage to the exposed shoreline. There is also a significant local fetch available for wind waves to reach the revetment site from the West-northwest sector of *circa* 10 to 14km in fetch length. This potentially would enable large local waves in excess of 1m, significant wave height, and possibly up to 2m, reaching Mweeloon Bay and if coinciding with high spring tides would break onto and over the revetment causing run-up and overtopping. **Figure 7-8** presents the seabed and ground surface levels at Tawin and Mweeloon. **Figure 7-9** presents the longitudinal profile A-A of the seabed and shore from inside Mweeloon Lagoon out to sea in a NW direction, with the different highwater levels included. This plot demonstrates that westerly waves diffracting around Tawin Island or local wind waves from WNW and NW sector if coinciding with highwater have sufficient depth to reach the revetment without breaking, particularly on spring tides and during storm surge events.

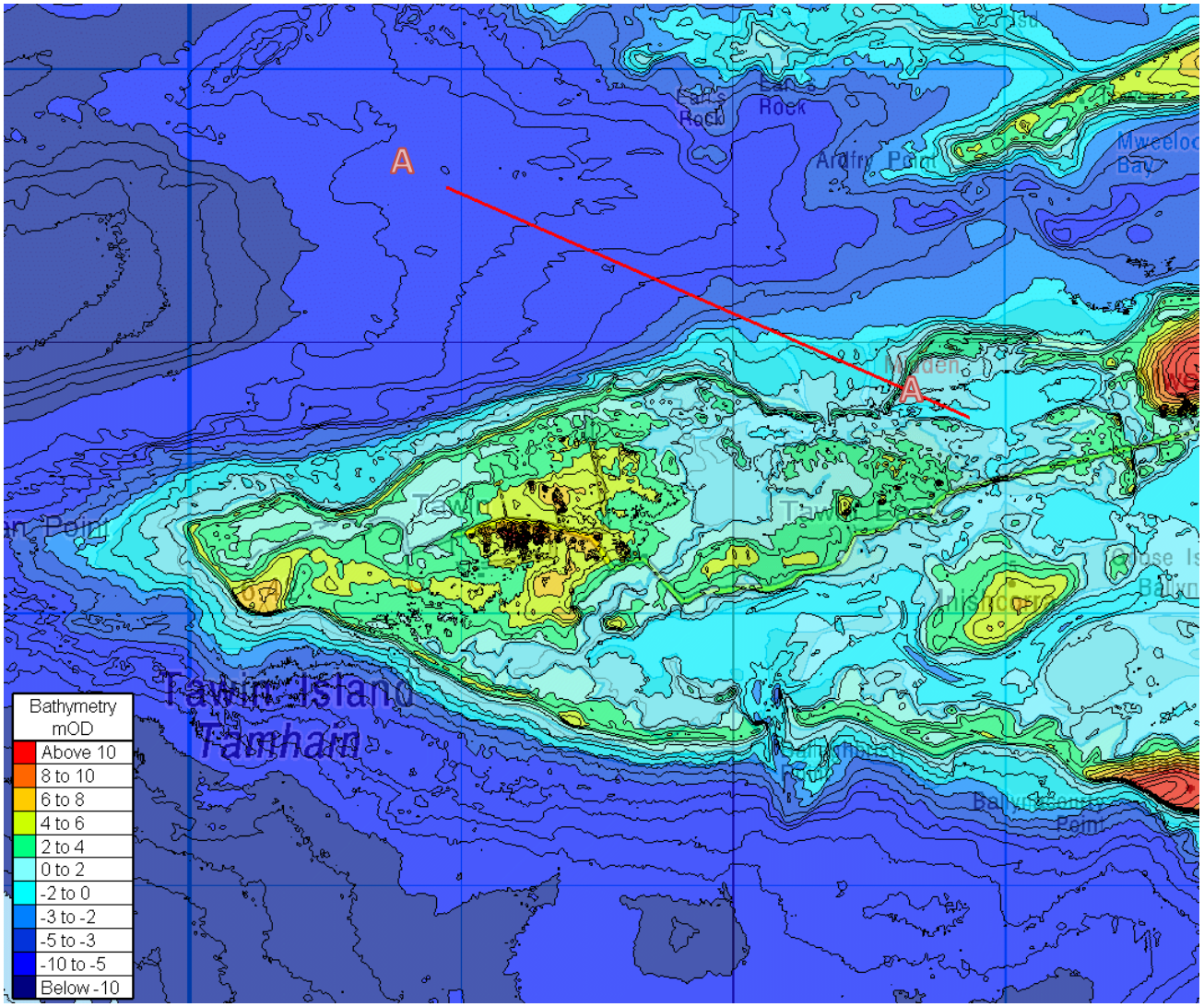


Figure 7-8: Topography and bathymetry of Tawin Island and Mweeloon from Infomar Lidar mOD Malin.

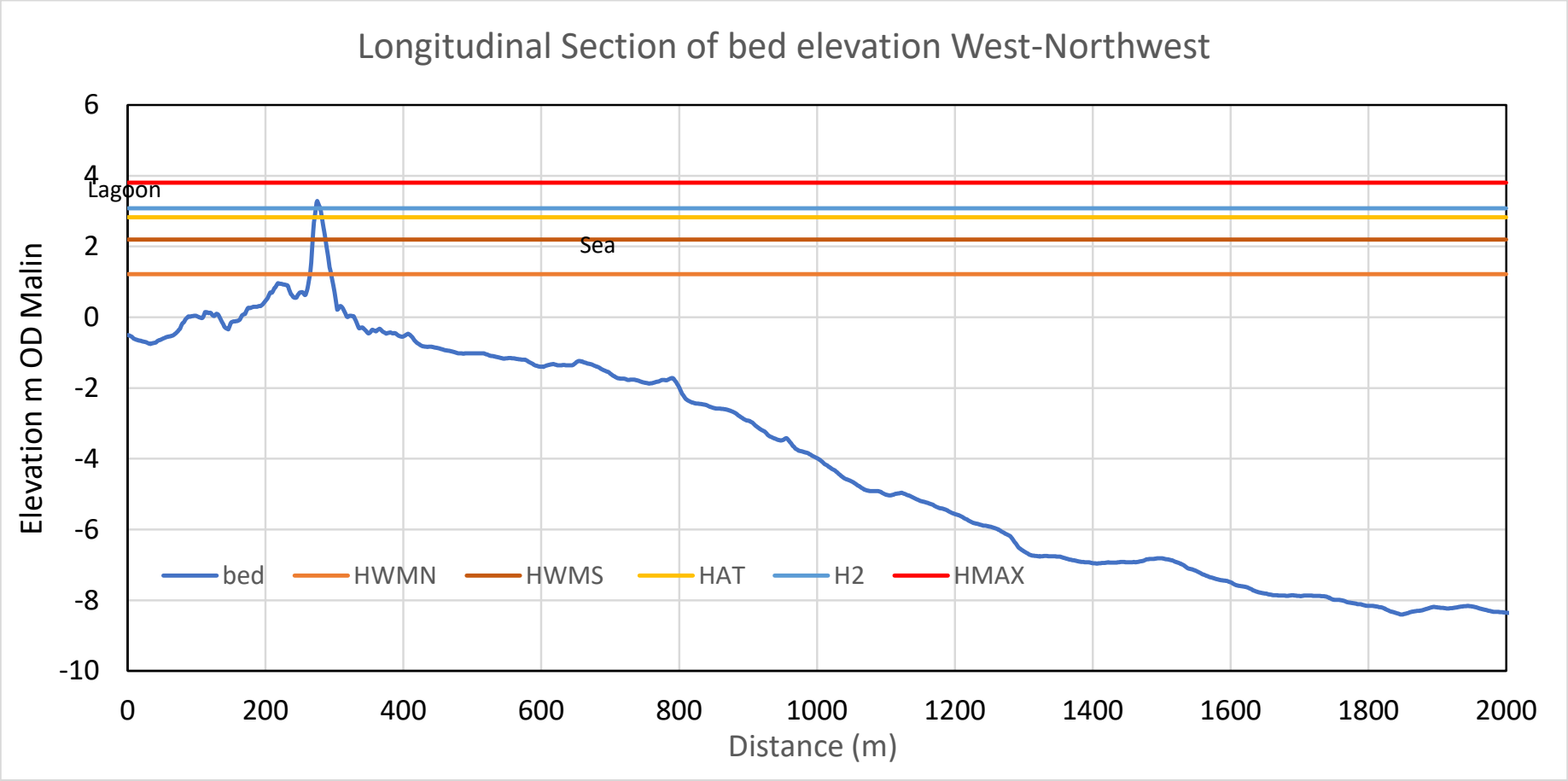


Figure 7-9: Longitudinal Profile A-A from Mweeloon Lagoon Northwest.

7.4.4.3. Tidal Exchange

There are three inlets/outlets to Mweeloon Lagoon, two are active over much of the tide, the first is via the channel entrance located at the southwestern end of Lurgan Island spit and revetment, the second is via the causeway road to Twain Island, through the bridge opening, at the south end of the lagoon and third inlet/outlet, which is at a higher invert level, is located at the northeast end of Lurgan Island and drains out across intertidal shore into Mweeloon Bay (refer to **Figure 7-6**). These are shown in Plates 6 to 8. The channel width of the inlets to the Lagoon are sufficiently wide as not to restrict tidal flows entering the lagoon such that highwater levels both within the lagoon and in the adjacent open bay are reasonably similar. The sill level of the inlet/outlets controls the low water level and the ebb flows and prevents the lagoon from fully drying out during the ebbing cycles.

It is also possible that some limited outflow from the lagoon occurs, diffusely, through the sandy shingle shoreline and via the limestone bedrock during the low tide periods. The inflow to the Lagoon is most likely to be confined to the surface inlet flow as opposed to Darcian flow through the shingle as there would be insufficient head difference available between the lagoon and the sea on the incoming tide. The salinity is likely to be similar to the open sea due to lack of freshwater inflows and the high tidal exchange and flushing within the lagoon.

A bathymetric Survey of the Mweeloon Lagoonal Area was carried out by AQUAFACT APEM Group in 2017 and again recently in November 2021 and are presented below **Figure 7-10** and **Figure 7-11**. This shows the lagoonal depth to be quite shallow with the deepest pools at -1 and -2mOD. The Lagoon Area at HWMS is *circa* 36ha and at Low water (0.0mOD) the surface area is only *circa* 8 to 10 ha.

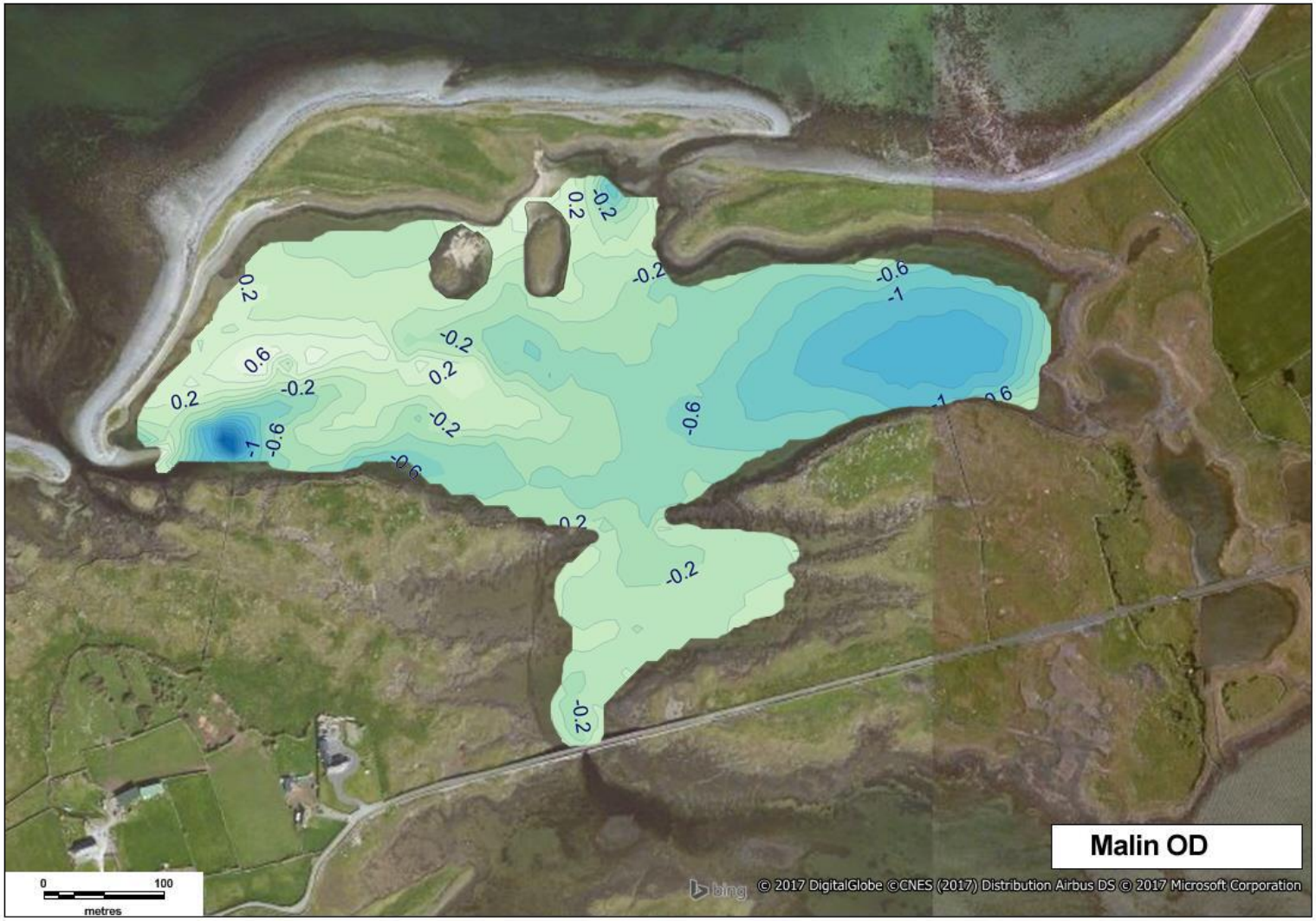


Figure 7-10: Bathymetric Survey of Mweeloon Lagoon Conducted by AQUAFACT APEM Group in 2017.

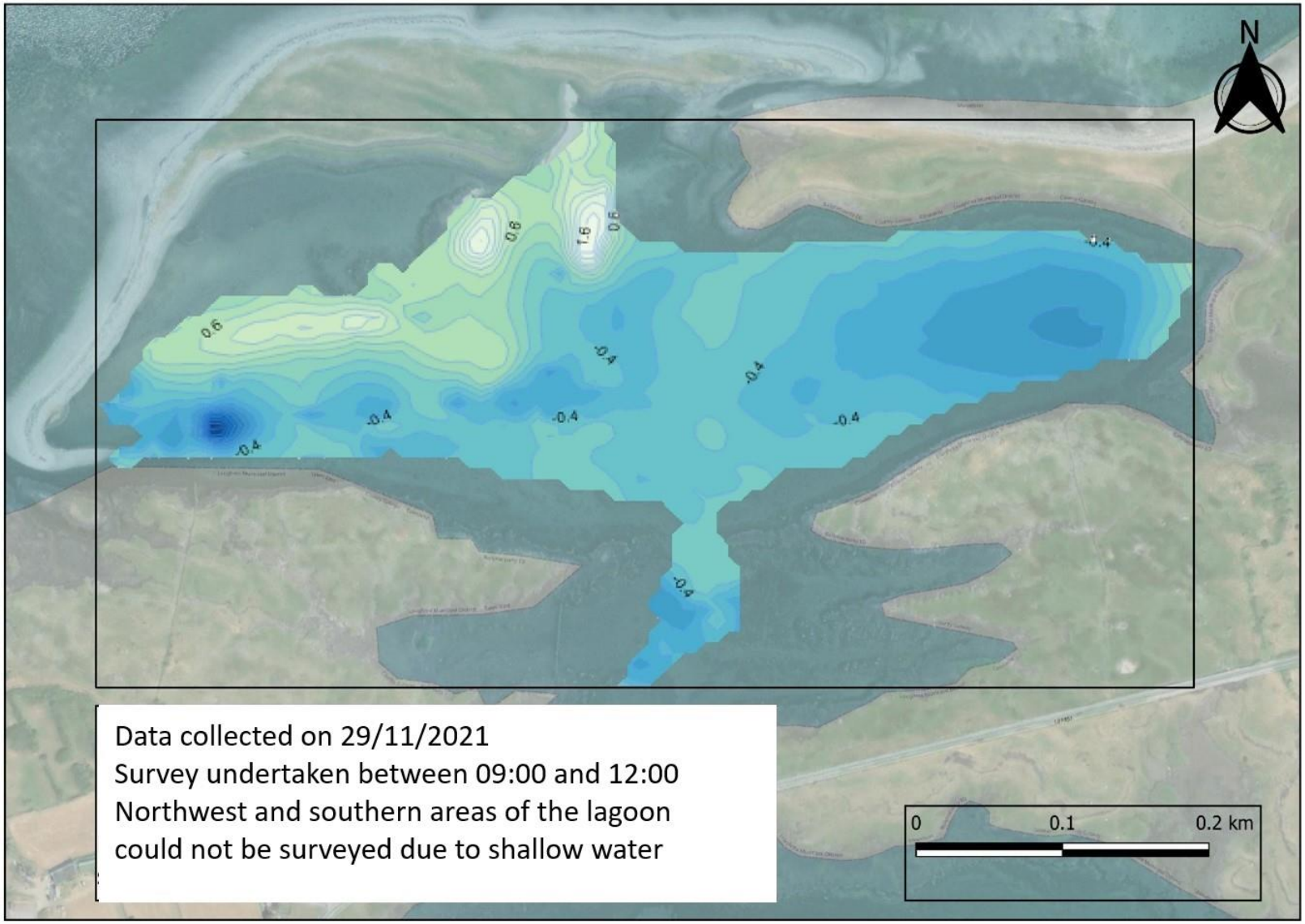


Figure 7-11: Bathymetric Survey of Mweeloon Lagoon Conducted by AQUAFACT APEM Group in 2021.

At highwater mean spring tides the estimated tidal volume within Mweeloon Lagoon is 546,000 m^3, based on the lidar and bathymetric survey data. At low tide water level within the Lagoon at sill level of *circa* 0.0m OD the tidal volume within the Lagoon is 21,000m^3. The mean spring exchange of tidal waters within the Lagoon is estimated to be 525,000m^3, which is almost 93% of the lagoonal volume exchanged each tidal cycle. The flood tide duration is approximately 3.5hours on spring tides representing an average inflow rate into Mweeloon Lagoon of *circa* 42 m^3/sec. The ebbing tide commences with strong outflows which recede rapidly over an 8-hour period as the lagoon empties down to its sill level. On mean Neap Tides the tidal volume within the lagoon at high water is approximately 257,000m^3 which is almost 50% of the spring tide volume.

The high spring tidal exchange rate of 93% each tidal cycle suggests that salinity is high and similar to the open bay. Salinity measurements carried out by AQUAFACT APEM Group confirm this. The high exchange rate within the lagoon ensures that local pollution from the surrounding lands would not easily build up in the lagoon except as deposited sediment. The lagoon has very limited drainage catchment for pollution sources to be an issue.

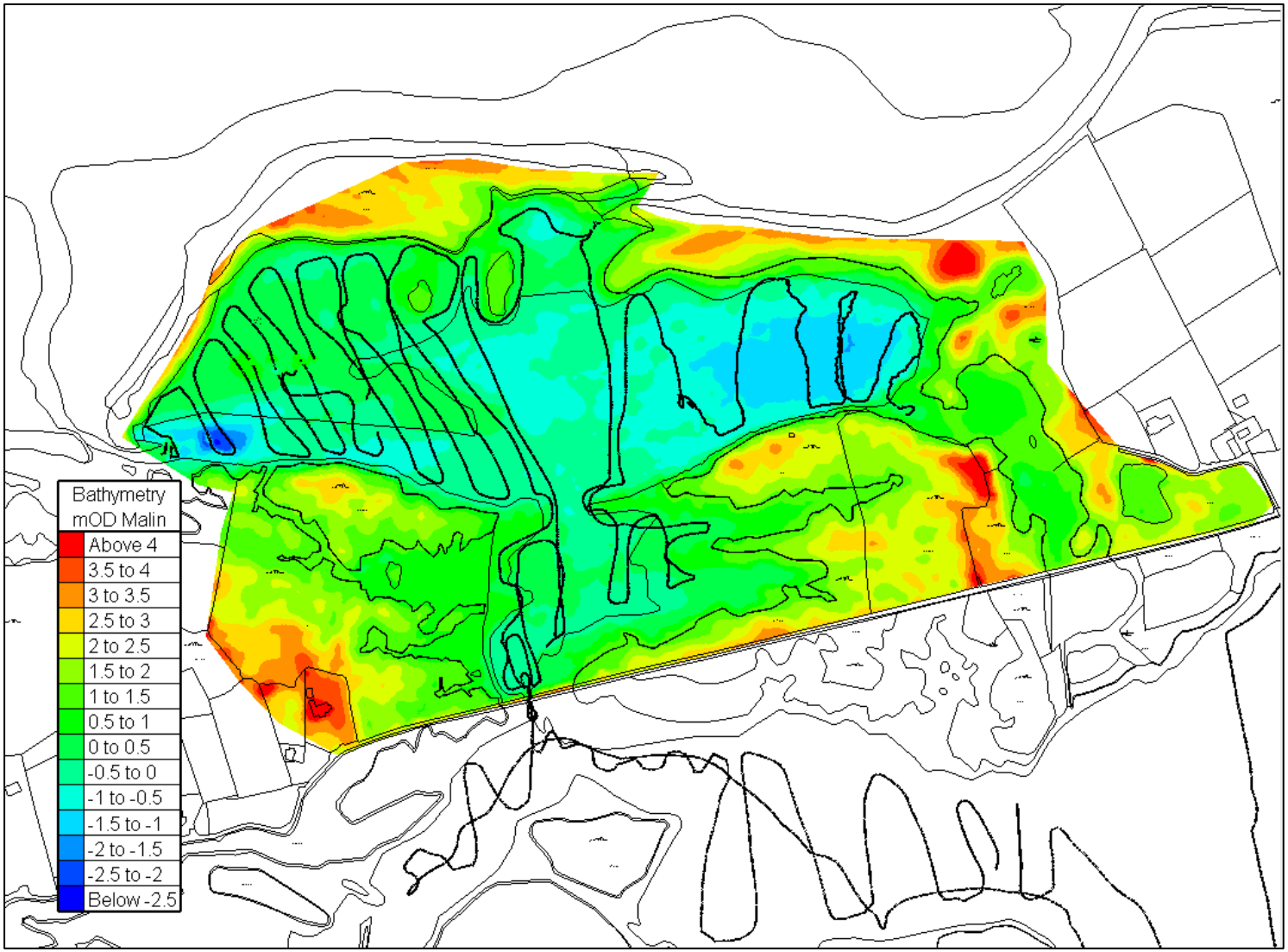


Figure 7.12 AQUAFACT APEM Group bathymetric data combined with GSI Infomar LiDAR.

Plate 6 Southern Channel at Ballynacloghy bridge on the Tawin Island local road.

Plate 7. Southwestern Channel at Lurgan Island.

Plate 8. Northeastern channel to Lagoon at Lurgan Island.

7.4.4.4. Sediment Transport

The sedimentology of the area is dynamic with episodes of coastal erosion arising out of short duration sea storm events and periods of benign conditions giving rise to deposition and stabilization. The finer material is likely to be transported into the lagoon via its inlet channels where it can eventually settle out within the lagoon. Periods of storms transport the heavier shingle material along the foreshore depositing it along the high watermark which is slightly upgradient of its wave breaking zone. Extreme sea storms deposit shingle onto the shore forming a natural shingle ridge that armours the shoreline. There is evidence of shingle being deposited well beyond the shoreline on Lurgan Island.

Shoreline sections most prone to damage are exposed sections and where the bedrock is deeper and the sands can easily be washed out by the breaking waves. Based on the Historical 25inch mapping allowing for mapping error there is evidence of a slow retreat of the shoreline area facing northwest and some deposition along the more sheltered northerly to northeasterly facing shoreline areas. The most dramatic changes in terms of erosion are along the western section of Lurgan Island which clearly shows a migration southeast of the shingle bank where the revetment was formed. The inlets to the Mweeloon Lagoon are maintained free of finer material and depth by the strong flooding and ebbing flows that fill and empty the lagoon.

A geophysical survey by Minerex Geophysics Ltd. (November 2021) (see **Appendix B**) was carried out to determine the ground conditions at Lurgan Island and along the revetment. The geophysical survey identified 4 seismic layers, with the upper Layers: 1 and 2 associated with the beach material and sediments of a very coarse nature, Layer 3 represents the top of the weathered limestone bedrock and tightly packed boulders and Layer 4 is competent good limestone bedrock. Both layer's 3 and 4 would be reasonably resistant to coastal erosion, whereas layer's 1 and 2 would be erodible. A transect S4 taken along the back of the revetment showed that the top of Layer 3 (weathered bedrock) varied in level from 0 to -2.5m OD with general level along the transect at -1.5m OD to top of layer 3. The top of Layer 4, representing good bedrock, was located between -2.5 and -5mOD. The sill level to the Lagoon at the southwestern end of Lurgan Island is at *circa* -0.4m OD suggesting that this may be formed by cobbles and shingle as opposed to bedrock features. The northeastern channel opening sill level at Lurgan Island is at *circa* 0.8mOD formed by the sediment as opposed to bedrock feature. The southern opening at the Ballynacloghy Road bridge would appear to be on bedrock at *circa* 0 to -0.2m OD. This geophysical survey of the Lurgan Island section indicates that the bedrock is not the controlling feature on the formation of the present lagoon sill levels and therefore bedrock is not sufficiently elevated to afford protection to the shoreline area and the lagoon against coastal erosion.

A number of survey transects from the open intertidal shore across the revetment into the lagoon have been surveyed (refer to **Appendix C**) which demonstrate the reduction in revetment level from its original designed level to its present day level as a result of coastal erosion. These transects form a baseline against which to compare quantitively changes in the ground profile as a result of coastal erosion events.

Internally, Mweeloon Lagoon is generally exposed to local wind waves predominantly from south to west sector which could impact the inner shoreline areas of Lurgan Island. However, the fetch is very limited at *circa* 250m, in respect to generating significant wave action that could significantly erode the inner permanent shoreline area and this process over the years would be relatively slow and is likely to be stable. Some erosion of the salt marsh edges is visible and this will continue to be monitored.

A future pressure on this lagoon area is likely to be from rising sea level which would reduce the shoreline area and salt marsh areas increasing the areas permanently under water and thus the shoreline area around the lagoon would be reduced.

7.4.5. Conclusion and Recommendation

The constructed ECAB revetment has failed to achieve its objective of protecting the shingle ridge shoreline behind the defences at the western end of Lurgan Island. The revetment will continue to fail through displacement and lowering as the surrounding shingle is removed under episodes of wave attack. It is not clear as to how much of this shingle bank has been pushed landward or washed seaward, but it is likely that heavier shingle material behind the revetment has been displaced landward towards the lagoon forming a flatter lower shingle area. There is no evidence of significant erosion at the exposed seaward face of this revetment nor is there evidence of shingle deposition along the face either. It is likely that the shingle is transported around to the north side of Lurgan Island.

The ECAB revetment is presently acting as a potential barrier to local deposition at this immediate location. The revetment, given its orientation, is only likely to be causing a local impact on sediment transport and there is no evidence that it has impacted on or represents an impact risk to the other sections of the stony bank shoreline at Lurgan Island or along the greater Tawin and Mweeloon shoreline areas.

It is recognized that this lagoon system and stony bank shoreline areas needs to be dynamic to compete with the increasing pressures from future sea level rise and increased storminess and that hard engineering solutions are often not the most sustainable solution and can turn from being a friend to being a foe.

Currently, this revetment is in place for more than 20 years and as such the lagoon has continued to function. In the medium term, this revetment will continue to be lowered and displaced, thereby reducing its effectiveness as a coastal defence barrier. This gradual lowering should facilitate a more natural sediment regime to function behind the defence. Given the current eroded state of the shingle ridge behind the revetment, the sudden removal of this revetment returning it to an unprotected state introduces unacceptable risk to the functioning of Mweeloon Lagoon, with the potential for complete erosion of the shingle barrier if left unprotected. This would allow more exposed wave conditions to enter Mweeloon Lagoon and erode the inner banks of the lagoon and potentially alter tidal flows and sediment regime within the lagoon.

Given the highly sensitive nature of the Mweeloon Lagoon, the stony bank shoreline and the salt marsh areas, all of which are qualifying interests of the Galway Bay SAC, decisions as to the appropriate management measures for the coastal defences at Lurgan Island require very careful consideration, backed by scientific understanding and analysis. The decision as to whether the defences should be retained, maintained, strengthened, lowered, replaced or removed altogether cannot be decided, as it requires considerable further studies over many years so as to ensure scientific certainty as to the potential impact on the SAC of such measures. It is therefore strongly recommended that no works to the sea defences be carried out at the present time, leaving them to their natural evolution, until a fuller scientific understanding of the implications of the management options on the site can be established.

Such management and monitoring studies will involve longer-term assessment and monitoring, post-planning and should be included as part of the commitments in the Compensatory Measures Plan. The future research and monitoring of the Shingle Bar at Lurgan Island and the Mweeloon Lagoon should be carried out by a multidisciplinary team that includes within the team a coastal geomorphologist. These future assessment and monitoring studies will involve regular detailed shoreline topographical surveys and bathymetric surveys, possibly utilising the current baseline survey transects (refer to **Appendix C** for locations), for comparison purposes, photographic surveys of the causeway ECAB units and ongoing monitoring of level and displacement of these units, detailed hydrodynamic and sediment transport modelling studies of the local and wider area, sediment sampling and distribution analysis, storm event analysis and the possible seeding of tracer sediments to identify and track movement of the shingle.

It is proposed that long-term tide level monitoring should be conducted involving the installation of water level recorders, one, within the Mweeloon Lagoon, a second in the southern Lagoonal area south of the Tawin causeway road and a third in the open sea near Mweeloon Bay.

The stony bank and sea defences at Lurgan Island act as a barrier between the open sea and Mweeloon lagoon, helping preserve the ecosystem function of this priority habitat by maintaining existing water regime, and circulation of sediment and organic matter.

A breach of the stony bank and sea defences at Lurgan Island could expose the inner lagoon area to greater flooding impact and to storm waves and much increased flow through Ballynacloghy Bridge into the larger lagoon to the south. To counter any breach and potential impacts to the lagoonal and adjacent salt marsh habitats, management actions including sensitive works of the stony bank and sea defences may be indicated. Detailed long-term monitoring and assessments will be undertaken to establish the potential implications of any management options (such as retaining, repairing, enhancing or removing) on the site and the Conservation Objectives of each of the relevant qualifying interests. Any proposed management actions will be submitted to the Planning Authority and NPWS/ DHGLG as part of the Annual Review process. It will be for NPWS/DHLGH to decide on any prioritisation of the Conservation Objectives for qualifying interests, should conflicting management actions be indicated. Depending on the nature of the proposed management actions, statutory approvals may also be required, such as planning permission or Ministerial Consent, all of which are subject to the requirements of the Habitats Directive, including appropriate assessment.

8. Technical Responses - Topic C

8.1. Compensatory Measures Marine Elements

GHC has acquired the control of two aquaculture licences within the compensatory area (Site ref: T09/376B and T09/377A) (see **Figure 8-1**). The Qualifying Feature habitats in the Mweeloon Compensatory Area overlapped by or adjacent to the aquaculture licenses in question include:

1. 1140 Tidal Mudflats and Sandflats (see **Figure 8-3**)
2. 1170 Reefs (see **Figure 8-3**)
3. 1160 Large Shallow Inlets and Bays (see **Figure 8-5**)

The marine community types identified within Qualifying Interest habitat 1140, 1160 and 1170 in relation to the aquaculture licenses are shown in **Figure 8-7**.

The conservation objective for 1140, 1160 and 1170 is 'To maintain the favourable conservation condition'. Favourable conservation condition of 1140, 1160 and 1170 is defined by the attributes and targets presented respectively **Table 8.1**, **Table 8.2** and **Table 8.3**.

Once the development is permitted, the intertidal areas of the licensed sites T09/376B and T09/377A will be cleared of all aquaculture structures and they will be preserved free of aquaculture activities. By leaving fallow parts of the intertidal habitat that are currently being used to farm oysters will allow the removal of pressures associated with operating the farms. The pressures are compaction of sediment along tractor access route, alteration of sediment conditions at trestles and infestation by non-native invasive species, *Didemnum vexillum*. The removal of the pressures will allow the recovery of the intertidal habitats previously impacted. **Table 8.1** through **Table 8.3** indicate the attributes and targets that the proposed Compensatory Measures will positively impact.

Figure 8-1: Aquaculture licensed sites.

Figure 8-2: Closer view of Aquaculture licensed sites

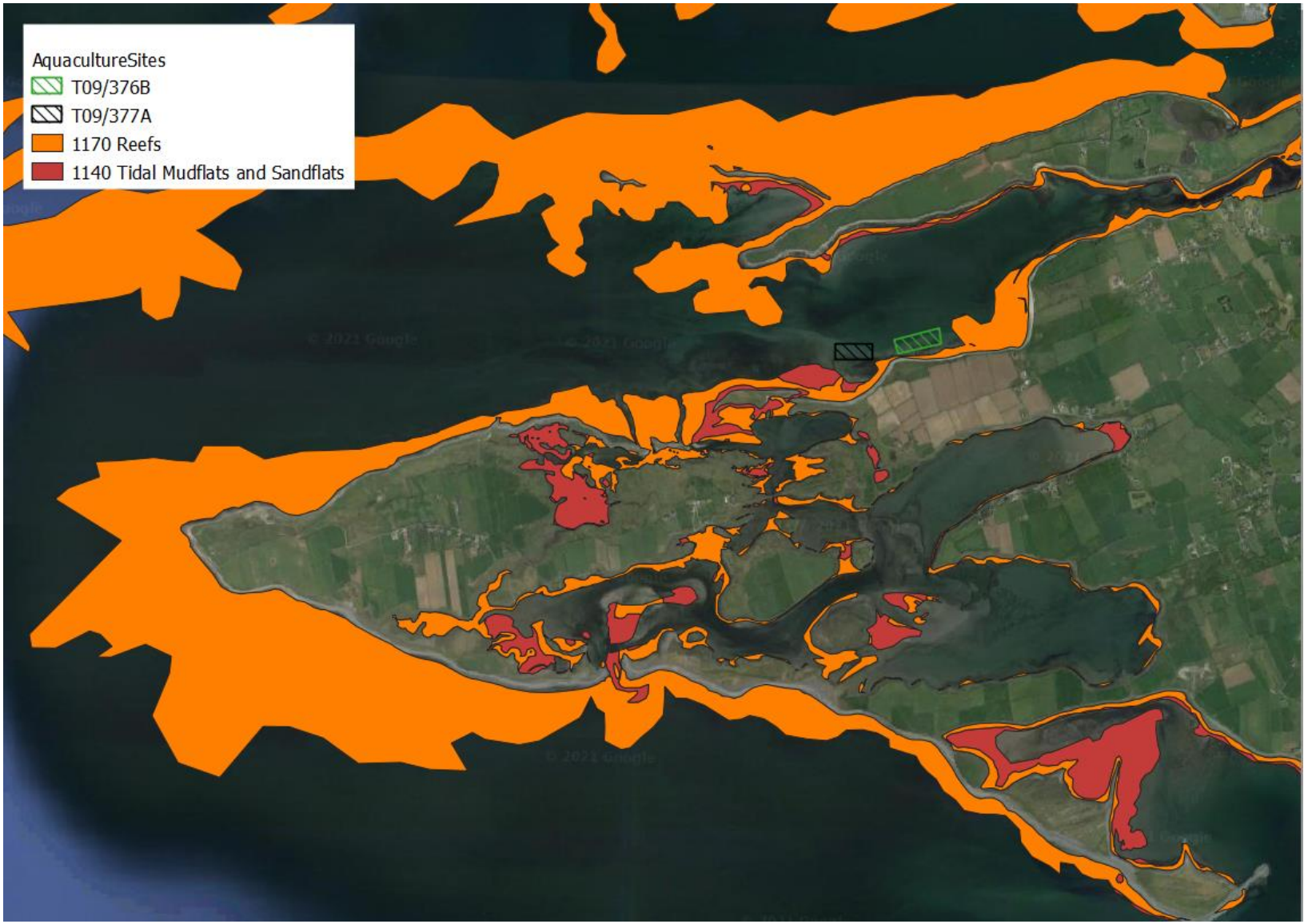


Figure 8-3: Aquaculture licensed sites relative to Qualifying Interest habitats 1170 Reefs and 1140 Tidal Mudflats and Sandflats.

Figure 8-4: Closer view of Aquaculture licensed sites relative to Qualifying Interest habitats 1170 Reefs and 1140 Tidal Mudflats and Sandflats.

Figure 8-5: Aquaculture licensed sites relative to Qualifying Interest habitat 1160 Large Shallow Inlets and Bays.

Figure 8-6: Closer view of Aquaculture licensed sites relative to Qualifying Interest habitat 1160 Large Shallow Inlets and Bays

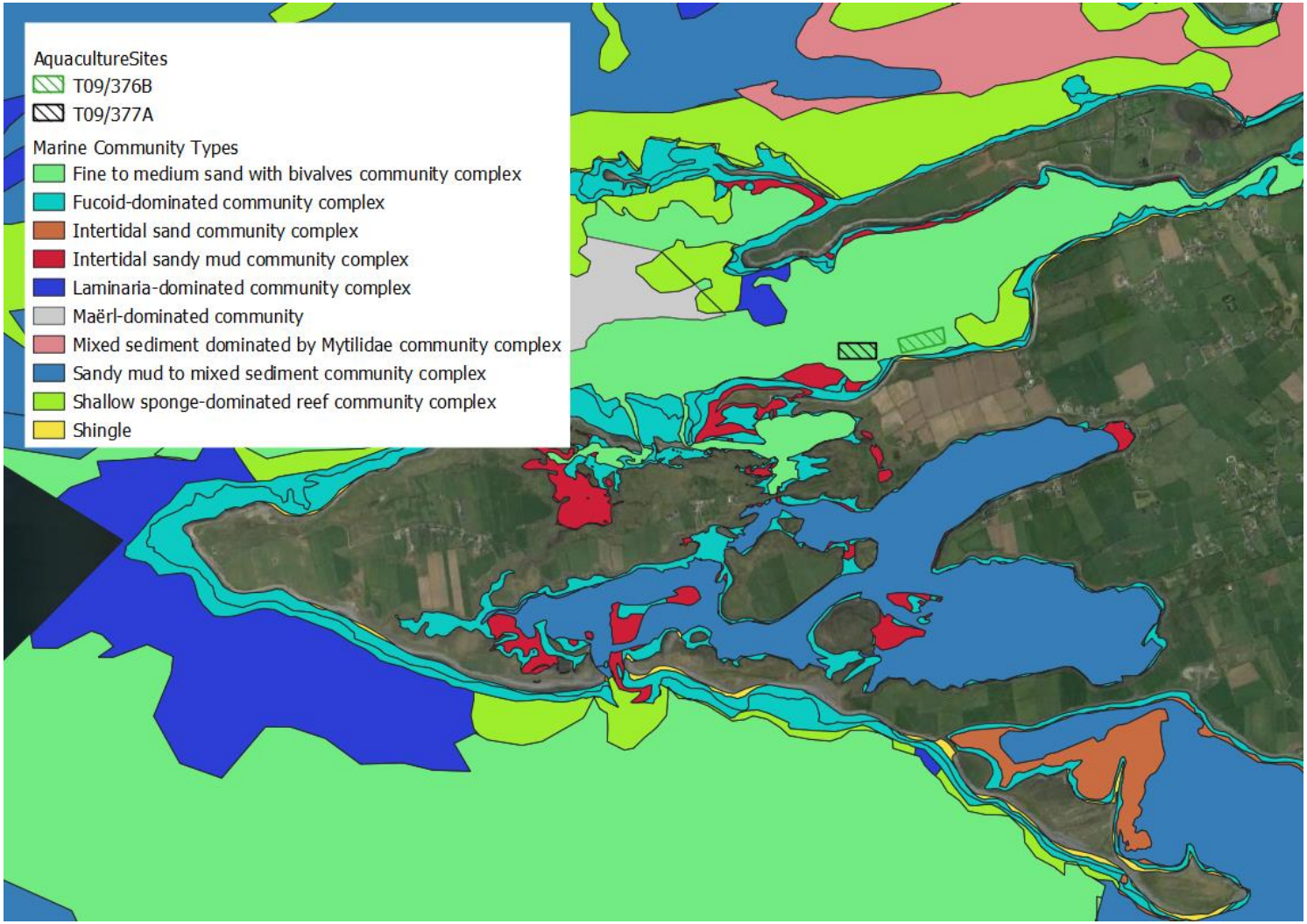


Figure 8-7: Aquaculture licensed sites relative to community types identified with Qualifying Interest habitat 1140, 1160 and 1170.

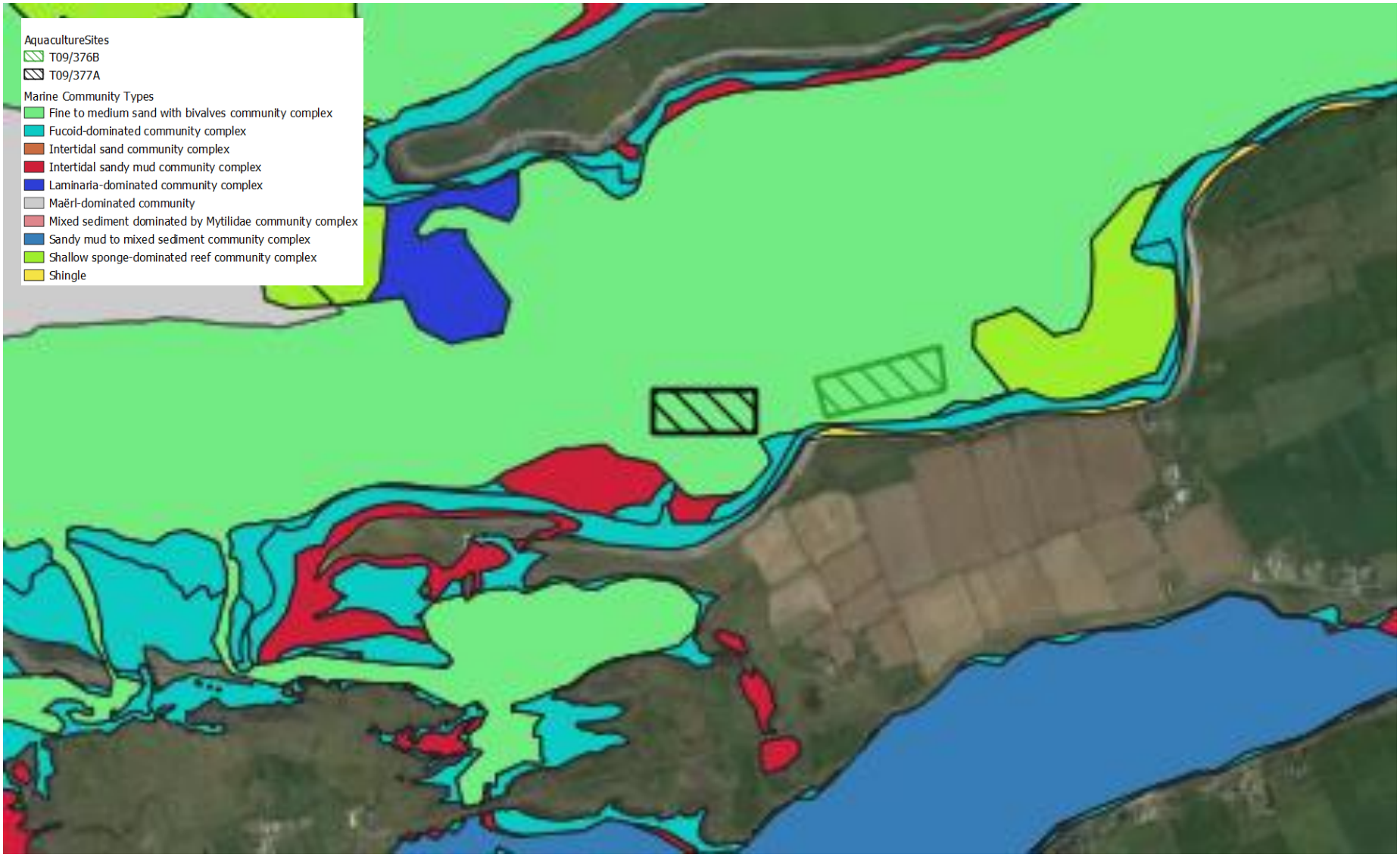


Figure 8-8: Closer view of Aquaculture licensed sites relative to community types identified with Qualifying Interest habitat 1140, 1160 and 1170.

Table 8.1: Conservation Objective and targets for habitat 1140 Tidal Mudflats and Sandflats in the Galway Bay Complex SAC (NPWS 2013).

Attribute	Measure	Target	Positive effect of Compensatory Measures
Habitat area	Hectares	Permanent habitat is stable or increasing, subject to natural processes.	Yes. Measures will ensure areas overlapped by the sites and access routes will be preserved in a natural state.
Community distribution	Hectares	Conserve the following community types in a natural condition: Intertidal sandy mud community complex and Intertidal sand community complex.	Yes. Measures will remove tractor traffic pressure acting on Intertidal sandy mud community complex located immediately adjacent to licensed sites.

Table 8.2: Conservation Objective and targets for habitat 1160 Large Shallow Inlets and Bays in the Galway Bay Complex SAC (NPWS 2013).

Attribute	Measure	Target	Positive effect of Compensatory Measures
Habitat area	Hectares	Area stable or increasing, subject to natural processes, including erosion and succession	Yes. Measures will ensure areas overlapped by the sites and access routes will be preserved in a natural state.
Community Extent	Hectares	Maintain the extent of the *Zostera*-dominated community complex and the maërl-dominated community, subject to natural processes.	Neutral. Note: the community types are not located within or adjacent to license areas.
Community structure: Zostera density	Shoots per m^2	Conserve the high quality of *Zostera*-dominated communities, subject to natural processes	Neutral. Note: the community type is not located within or adjacent to license areas.
Community structure	Biological composition	Conserve the high quality of the maërl-dominated community, subject to natural processes	Neutral. Note: the community type is not located within or adjacent to license areas.

Attribute	Measure	Target	Positive effect of Compensatory Measures
Community distribution	Occurrence	Conserve the following community types in a natural condition: Intertidal sandy mud community complex; Intertidal sand community complex; Fine to medium sand with bivalves community complex; Sandy mud to mixed sediment community complex; Mixed sediment dominated by Mytilidae community complex; Shingle; Fucoid-dominated community complex; *Laminaria*-dominated community complex; and Shallow sponge-dominated community complex.	Yes. Measures will remove pressures acting on: Intertidal sandy mud community complex; Fine to medium sand with bivalves community complex; Fucoid-dominated community complex; Shingle;

Table 8.3: Conservation Objective and targets for habitats 1170 Reefs in the Galway Bay Complex SAC (NPWS 2013).

Attribute	Measure	Target	Positive effect of Compensatory Measures
Distribution	Occurrence	The distribution of reefs is stable or increasing, subject to natural processes	Yes. Measures will ensure areas overlapped by the sites and access routes will be preserved in a natural state.
Habitat area	Hectares	The permanent habitat area is stable, subject to natural processes	Yes. Measures will ensure areas overlapped by the sites and access routes will be preserved in a natural state.
Community extent	Hectares	Maintain the extent of the *Mytilus*-dominated reef community, subject to natural processes.	Neutral. Note: the community type is not located within or adjacent to license areas.
Community structure: Mytilus density	Individuals per m^2	Conserve the high quality of the *Mytilus*-dominated reef community, subject to natural processes	Neutral. Note: the community type is not located within or adjacent to license areas.
Community structure	Biological composition	Conserve the following community types in a natural condition: Fucoid-dominated community complex; *Laminaria*-dominated	Yes. Measures will remove pressures acting on: Fucoid-dominated community complex.

Attribute	Measure	Target	Positive effect of Compensatory Measures
		community complex; and Shallow sponge-dominated community complex	

8.1.1. Objective 1 The control of the invasive, non-native tunicate species *Didemnum* in Mweeloon Bay.

Didemnum vexillum is an invasive colonial sea squirt (tunicate) that grows in bays and coastal waters and can form extensive mats on rocky substrates and artificial substrates. At Mweeloon *Didemnum* is found on intertidal oyster trestles and bags, and on rocks, cobbles, boulders, rock outcrops in the area. The *Didemnum vexillum* management control area in the Mweeloon Compensatory Area extends from Lurgan Island eastwards to the southeastern shoreline of Mweeloon Bay (see **Figure 8-9)**.

The target of this element of the Intertidal Management Plan is to control the population of *Didemnum* which is present on oyster trestles and bags, and other hard surfaces at the site. Using the SACFOR scale (Superabundant, Abundant, Common, Frequent, Occasional, Rare) to describe % cover of the tunicate at the oyster farms at present, it is scored at Abundant.

8.1.1.1. Method

An annual control regime for the species is proposed as part of the Compensatory Measures.

An objective of the control regime is to reduce the population of *Didemnum* in the area by removing trestles and bags to reduce the area of artificial structure available for colonisation.

For the trestles and bags that will remain in use at Mweeloon, the control regime focuses on methods that are known to be an effective method to control *Didemnum.* These methods include the regular turning of the oyster bags to increase "drying out" periods and spraying with acetic acid (vinegar) by hand to treat and kill the tunicate *in situ*.

To date some trestles and bags previously actively used at Mweeloon have been removed allowing localised reductions in population levels. However, where trestles and bags remain *Didemnum* persists. *Didemnum* is also known to persist at hard substrate areas (*e.g.* rocks, cobbles, boulders, rock outcrops).

8.1.1.2. Indicator

The Abundance and Distribution Range method (ADR) developed by Olenin *et al.* (2007) and used recently by Cottier-Cook *et al*. (2019) in a survey of *Didemnum* in Loch Creran, Scotland is the indicator that will be used to measure the relative effectiveness of the control regime at Mweeloon. Use of the ADR tool will readily and quickly show the effectiveness of the control regime.

In addition, a photographic survey will be carried out to visually document the population and distribution of *Didemnum* before the control practice commences and on an annual basis post-commencement.

It is proposed to carry out this *Didemnum* control regime throughout the entire reference site (*i.e.* Areas 1, 2, 3 and 4 shown on **Figure 8-10**). This is to ensure that, if populations are left in close proximity to the fallow site, they cannot re-infest the fallow area.

8.1.1.3. Threshold

The threshold for this objective of the Intertidal Management Plan is to reduce the percentage cover of *Didemnum* in Mweeloon Bay to within *circa* 50% of what it is at the start of the Plan within 5 years of its

commencement. In future years, it may be possible to achieve total removal of the tunicate at the farmed site.

The control of the invasive tunicate *Didemnum* will evolve depending on results *etc* and that the efficacy of the treatment would be checked shortly after use and repeated if necessary to ensure a satisfactory control is achieved.

8.1.1.4. Management Goal

The presence of the non-native tunicate *Didemnum* at the Mweeloon aquaculture site that lies within Galway Bay SAC is, in conservation terms, an unacceptable fact. Removing and controlling the tunicate at least from a part of the SAC is an important management goal of this objective. The measures to control of the *Didemnum* will evolve depending on results *etc* and that the efficacy of the treatment would be checked shortly after use and repeated if necessary to ensure a satisfactory control is achieved.

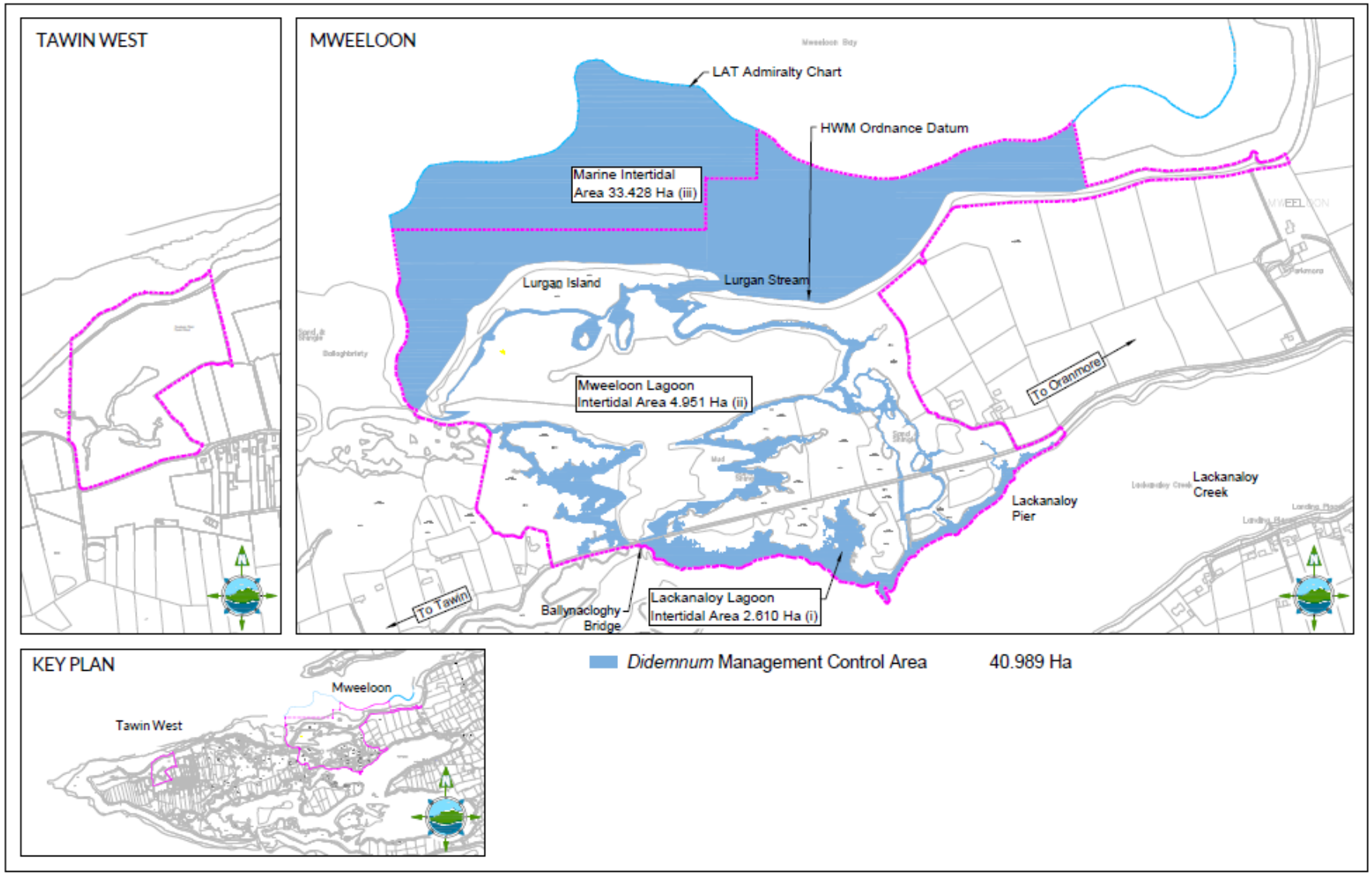


Figure 8-9: *Didemnum* Management Control Area.

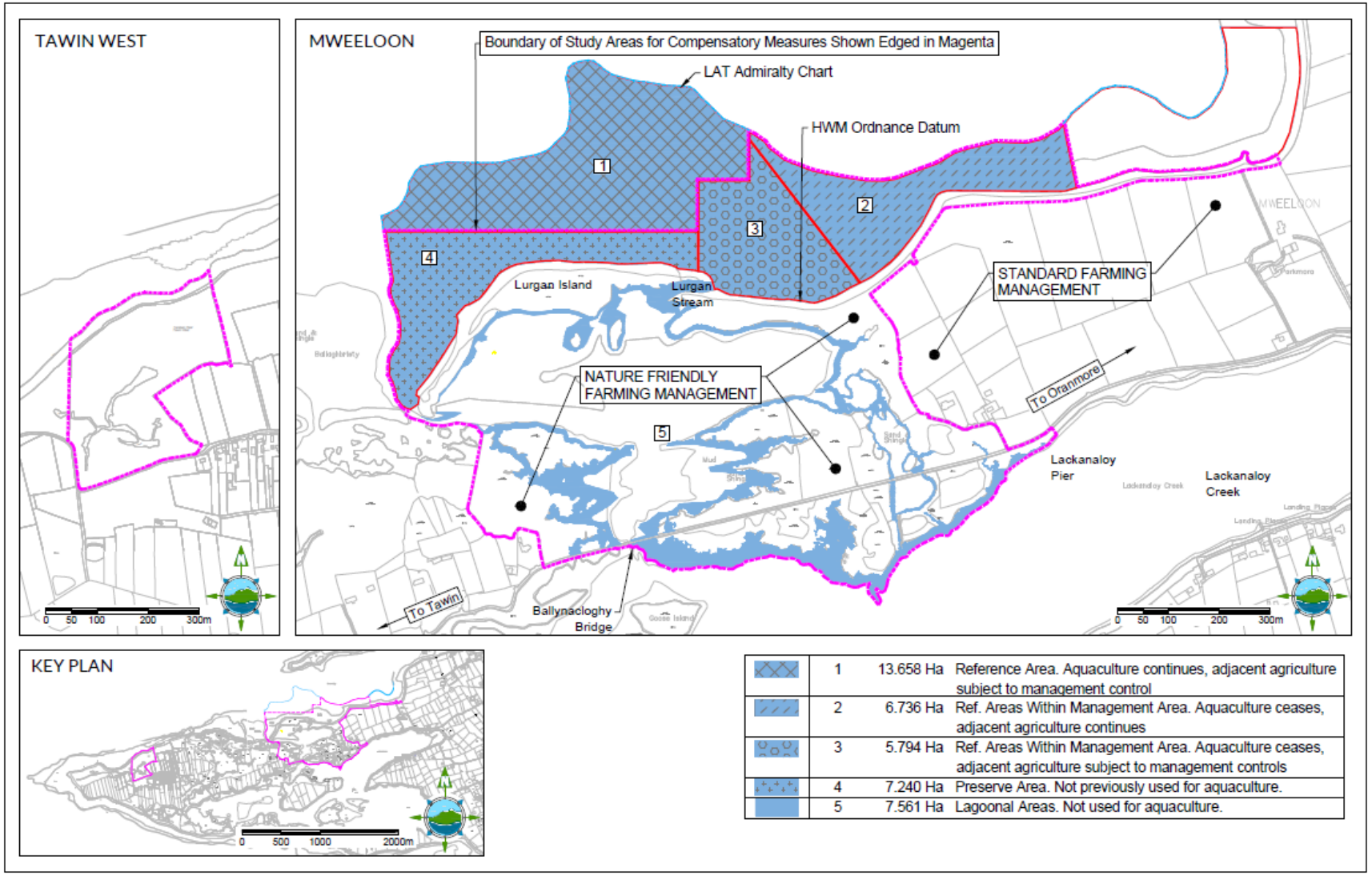


Figure 8-10: Reference areas.

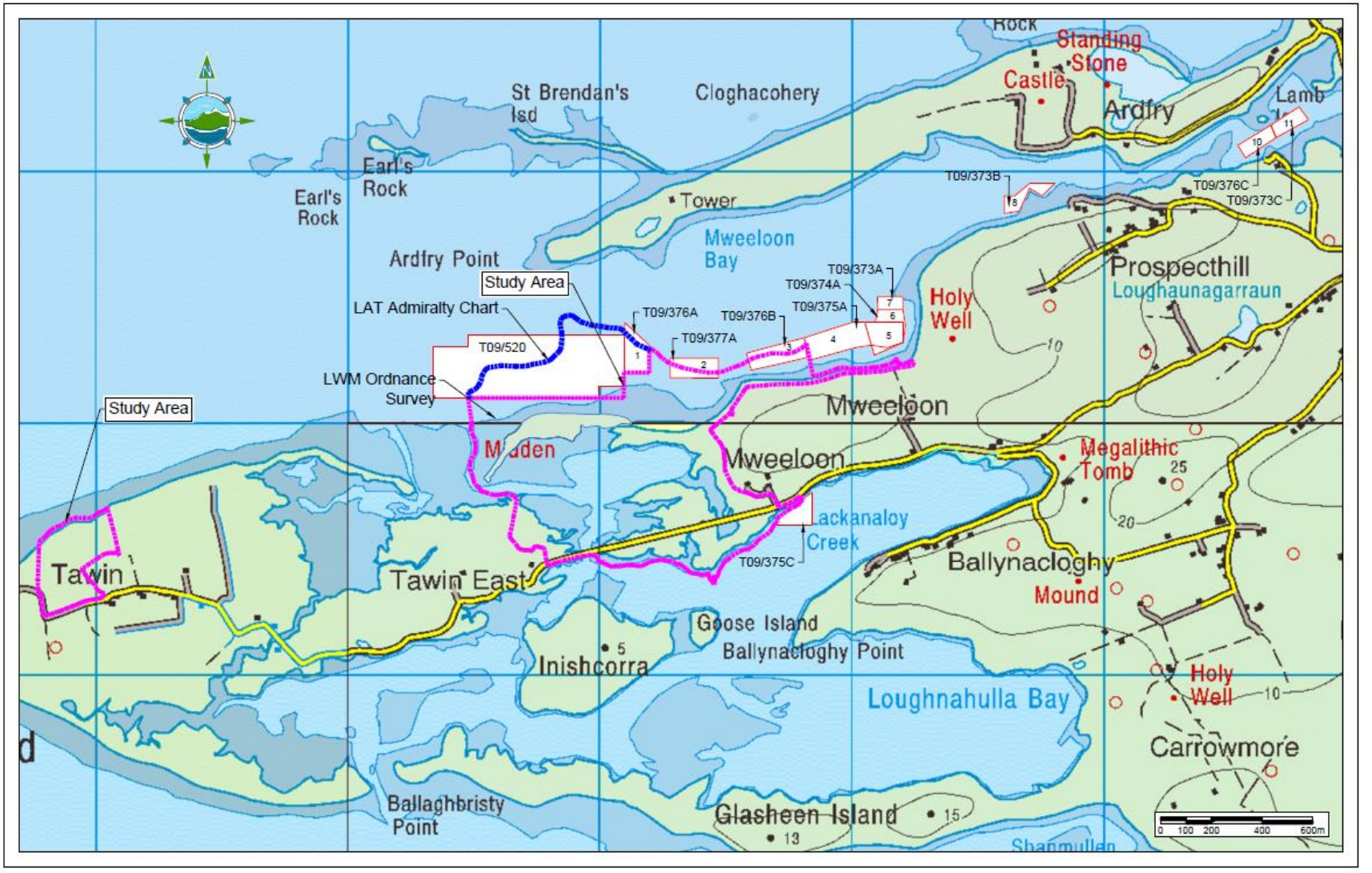


Figure 8-11: Aquaculture License Sites in Study Areas.

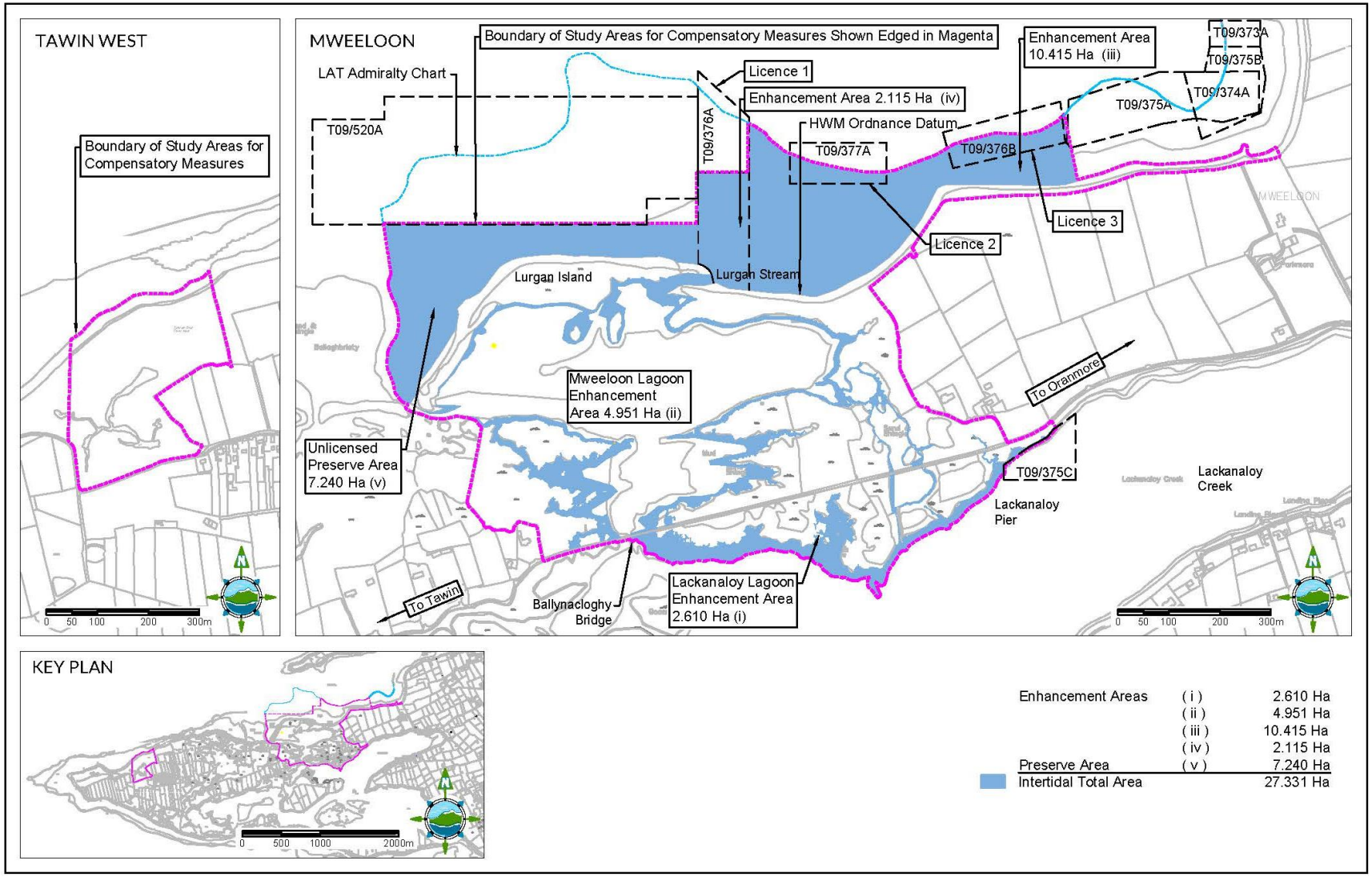


Figure 8-12: Aquaculture Licence Sites in Intertidal Management Area.

8.1.2. Objective 2. The removal of oyster trestles and cessation of tractor movements from the reference area.

The second target of the marine aspect of the Intertidal Management Plan is the permanent fallowing of sites in Mweeloon Bay that are currently used for culturing oysters including the elimination of tractor traffic to and from the fallow sites

8.1.2.1. Methods

The details of the monitoring methods for this objective are presented in **Section 8.1.4**.

8.1.2.2. Indicators

It is intended that the experimental design, methodologies and indicators used in the Forde *et al*. (2015) study will be used to track change over time at the Mweeloon site following the removal of the trestles and cessation of tractor traffic. Specifically, univariate and multivariate statistical analyses (PRIMER, PERMANOVA) will be used to assess changes in sediment characteristics, faunal diversity measures and IQI ES (see **Section 8.1.4** for further detail).

The full suite of analysed data will provide a comprehensive and robust data set on which to base conclusions from the results of the statistical analyses. It will also allow comparisons in "*ante et post*" conditions at the fallow site, the active production site and the access route.

8.1.2.3. Thresholds

Details on threshold levels for biological data, organic carbon levels and mean size of sand particles are presented in **Section 8.1.4**.

8.1.2.4. Management Goal

The objective of this target is to be able to demonstrate the effects of fallowing oyster production sites on intertidal benthic ecology. Given the number of sampling locations, the number of replicates and the temporal extent of the survey period (as presented in **Section 8.1.4**), it is considered that this sampling strategy is adequately specific to:

1. Establish a baseline of the intertidal habitat and
2. Determine the success of this aspect of the compensatory measure.

Success of this aspect of the Compensatory Measures is defined as the stabilisation of the benthic fauna at the fallow sites and on the former access routes in comparison to what is present at the trestle and access route.

8.1.3. Objective 3. Establishment of "nature friendly" farming practices

The commencement of "nature friendly" farming practices including reduced stocking densities, and non-use of fertilizers may bring about changes in intertidal ecology including the reduction in the spatial extent of green algae that are known to react positively to increased levels of organic enrichment. The presence/absence and percentage cover of green algae such as *Ulva* (+ synonym *Enteromorpha*) will be documented as part of each annual survey to record changes in intertidal ecology due to these alterations in agricultural practices.

8.1.3.1. Method

At the Mweeloon area, benthic samples will be recovered at 10 stations at fallowed aquaculture sites adjacent to an area of intensive agriculture (**Figure 8-10**, Area 2) and an area of "nature friendly" agriculture (**Figure 8-10**, Area 3 & 4).

The same methods as outlined for Objective 2 will be applied to these surveys. A much longer time scale (decadal) is required to demonstrate this and well may be masked by a stronger signal such as a rise sea temperature or an increase in storm activity

8.1.3.2. Indicators

The same suite of indicators as listed in **Section 8.1.4** for the study on the fallowing of oyster culture sites will be used in the Objective 3 study.

8.1.3.3. Threshold

As is noted above in the methods section, a much longer time scale (decadal) is required to demonstrate this an as the response may be masked by a stronger signal, it is not possible to set a threshold level for this target.

8.1.3.4. Management Goal

One potential positive aspect of this section of the CMP is that it may demonstrate, over an extended time period, a reduction in green algae on the shore.

8.1.4. Methodology - Objective 2 and Objective 3

The effects of mollusc aquaculture on marine ecology has received some focus of research not only in Ireland (Forde *et al.,* 2015 *inter alia*) but also further afield (for reviews see McKindsey *et al.,* 2011; Gallardi, 2014). Forde *et al.* (2015) investigated the impact of oyster trestle cultivation activities on intertidal soft sediment habitats and infaunal communities at six sites located within four designated Natura 2000 sites distributed around the north-west, west and south coasts of Ireland. Specifically, the study investigated changes in sediment characteristics and associated infaunal communities 1) underneath trestles and 2) along access routes.

Results showed that sediment characteristics and the associated infaunal community structure and diversity indicators across the sites was highly variable, with increases in species abundance and diversity attributed to faecal/pseudofaecal material produced by the oysters acting as a source of additional food for the infaunal taxa. The variability across sites prevented the detection of the general effects of cultivation activity on sediment characteristic and faunal community structure. To overcome variability, the Water Framework Directive (WFD) Ecological Quality Ratio (EQR) Infaunal Quality Index (IQI) indicator was used to assess impacts on the Ecological Status (ES) of the infaunal communities.

This study showed that traffic along access routes had a significant negative impact on ES. The negative impact on ES was attributed to tractor and trailer traffic and the consequent compaction of sediments. This study highlighted the IQI EQR indicator as a tool for the management of aquaculture activity and as a potential tool for assessing the conservation status of designated habitats in Natura 2000 sites.

Within the Mweeloon marine reference site (**Figure 8-10**), four areas will be selected and these are as follows:

1. At the trestles of an active aquaculture site and adjacent to an area of intensive agriculture including the access route to and from it,
2. At an aquaculture site that will be fallowed and adjacent to an area of intensive agriculture,
3. At an aquaculture site that will be fallowed and adjacent to an area of "nature friendly" agriculture and
4. At a location on the tractor access route to the active aquaculture site.

Within each of these including the access routes, 10 stations will be selected. At each station two core samples will be taken, one core for faunal analysis and one core for sediment granulometry and organic carbon analysis. At each station, REDOX depth will be at the assessed visually using a transparent, plastic

core. Summaries of the faunal and sediment analyses are presented below. Sampling will be carried out as listed below:

1. Before the trestles are removed
2. 1 week post removal
3. 1 month post removal
4. 6 months post removal
5. 1 year post removal
6. Once a year for 5 years post removal

The temporal changes at the fallowed sites will be compared to temporal changes at a nearby trestle oyster site where cultivation activity will be continued *i.e.* an active production site and at the access route. All sites to be investigated will be selected to ensure that they are comparable in terms of shore tidal height and sediment type.

Samples for quantitative faunal analysis will be sieved on a 1mm mesh sieve, preserved, sorted and identified to species level where possible.

The faunal samples will be processed in a systematic way to ensure that no samples are omitted. A daily inventory of what samples have been sorted/identified/counted will be maintained.

Conspicuous fauna will be placed in an illuminated shallow white tray and sorted first by eye to remove large specimens and then sorted using a stereo microscope at 6 to 10 times magnification. Following the removal of larger specimens, the samples will be placed into Petri dishes, approximately one-half teaspoon at a time and sorted using a binocular microscope at x25 magnification. The fauna will be maintained in stabilised 70% industrial methylated spirit (IMS) following retrieval and identified to species level where practical using a binocular microscope, a compound microscope and all relevant taxonomic keys. AQUAFACT APEM Group has an extensive library of taxonomic publications (including BEQUALM/NMBAQC guides).

Species nomenclature will be classified in accordance with Howson & Picton (1997). After identification and enumeration, specimens will be separated and stored to species where possible. All containers will be clearly labelled on the outside stating site, date, sample code, replicate number and name of individual who analysed the sample. A permanent internal label bearing the same information will also be included with all containers. Specimens will be stored in stabilised Industrial Methylated Spirits (IMS) in containers with adequate seals and labelled accordingly. Residual detritus will be kept in a separate container for each sample, labelled inside and outside. Sample residue will be preserved in alcohol in containers with adequate seals and labelled accordingly. All faunal abundance data will be recorded in an Excel spreadsheet. The following description outlines the methodology for granulometric analyses.

Approximately 25g of dried sediment is weighed out and placed in a labelled 1L glass beaker to which 100 ml of a 6 percent hydrogen peroxide solution is then added. This is allowed to stand overnight in a fume hood. The beaker is placed on a hot plate and heated gently. Small quantities of hydrogen peroxide are added to the beaker until there is no further reaction. This peroxide treatment removes any organic material from the sediment which can interfere with grain size determination. The beaker is then emptied of sediment and rinsed into a 63µm sieve. This is then washed with distilled water to remove any residual hydrogen peroxide. The sample retained on the sieve is then carefully washed back into the glass beaker up to a volume of approximately 250ml of distilled water. 10ml of sodium hexametaphosphate solution is added to the beaker and this solution is stirred for ten minutes and then allowed to stand overnight. This treatment helps to dissociate the clay particles from one another. The beaker with the sediment and sodium hexametaphosphate solution is washed and rinsed into a 63µm sieve. The retained sample is carefully washed from the sieve into a labelled aluminium tray and placed in an oven for drying at 100ºC for 24 hours. When dry this sediment is sieved through a series of graduated sieves ranging from 4 mm down to 63µm for 10 minutes using an automated column shaker. The fraction of sediment retained in each of the different sized sieves is weighed and recorded. The

silt/clay fraction is determined by subtracting all weighed fractions from the initial starting weight of sediment as the less than 63µm fraction was lost during the various washing stages.

The particle size (PSA) data will be processed using GRADISTAT (Blott and Pye, 2001) software to derive sediment type classification and sediment particle parameters including (ø) particle graphic mean values (Mz) and sediment distribution modality. All sediment samples will be classified using Folk and Ward (1957). Mz is a parameter used to describe the mean particle size of a distribution and is analogous to the graphic mean employed with the normal distribution in conventional statistics (Forde *et al*., 2012); consequently, the Mz parameter can be used with confidence where sediments exhibit unimodal distributions. If the particle size distribution of the sediment is unimodal (or approximately unimodal), Mz values will be used to track change in average particle size over time.

Regarding statistical analyses, univariate statistics will include:

1. Species richness which is a measure of the total number of species present for a given number of individuals.
2. Evenness which is a measure of how evenly the individuals are distributed among different species.
3. The Shannon-Wiener index which incorporates both species richness and the evenness component of diversity.
4. This diversity index is then converted to Effective Species Number (ENS) to reflect 'true diversities' that can then be compared across communities. The ENS is equivalent to the number of equally abundant species that would be needed in each sample to give the same value of a diversity index, *i.e.* Shannon-Weiner Diversity index. The ENS behaves as one would intuitively expect when diversity is doubled or halved, while other standard indices of diversity do not. If the ENS of one community is twice that of another then it can be said that that community is twice as diverse as the other.
5. Multivariate statistical analyses will be used to investigate change in community structure.

Other indicators will include the level of reduction of organic carbon in the sediments and the increase in median particle size (Mz) at the fallow site in comparison to the actively farmed site.

8.1.4.1. Thresholds

Based on the results of Forde *et al.,* (2015), it is predicted that as there will less organic matter in the sediment post-fallowing, numbers of individuals of suspension and deposit feeding taxa such as *Macomangulus* and *Polycirrus* (that were recorded in the reference area of Mweeloon as part of the intertidal survey for the CMP report) will decrease. The threshold for these taxa is that there will be a statistically significant reduction in their densities 5 years post-removal.

Amphipoda are known to be sensitive to increased organic carbon loadings and densities in taxa such as *Bathyporeia* (that has also been recorded at the site) are predicted to increase post-fallowing. The threshold for densities of these taxa is that there will be a statistically significant increase in their densities 5 years post-removal. Nematoda and Oligochaeta are known to be tolerant to increases in organic loadings and a threshold for densities of these taxa is that there will be a statistically significant reduction in their densities 5 years post-removal.

With regard to changes in numbers of individuals and numbers of species, it is predicted that post-removal of trestles, this should be reflected in the Effective Species Number (ENS). A threshold for the ENS is that there will be a statistically significant reduction in ENS 5 years post-removal.

Threshold values for a decrease in levels of organic carbon and mean grain size is that there will be a statistically significant reduction in these values 5 years post-removal.

Regarding the access route, it is predicted that numbers of species and numbers of individuals will increase over time. A threshold for densities of taxa is that there will be a statistically significant reduction 5 years post-removal.

9. Technical Responses - Topic D

Following close consultation and discussions with the current owners and lessees of the lands at Mweeloon it was decided that a light grazing regime will be implemented between 1st of May and 31st of October, at a grazing intensity of between 0.5 to 1.0 LU per hectare. Grazing during these months will be closely monitored.

At Tawin West Compensatory Measures will be set in place to regulate grazing to reduce overgrazing and dunging and to a lesser extent, poaching of the habitat. There will be no grazing between the 1st of April and the 31st of August. A light grazing regime will be implemented between the 1st of September and the 31st of March at a grazing intensity of between 0.5 to 1.0 LU per hectare.

As the areas at Mweeloon and Tawin West will be subject to different grazing regimes, the results of the vegetation monitoring will provide important information regarding the ecological management of vegetation in salt marsh and stony bank areas.

The areas to be grazed at Mweeloon and Tawin West will be compared and will therefore act as reference areas to each other. This will ensure that potential problems such as localized poaching will be identified at an early stage and the appropriate management measures can be taken.

Vegetation surveys will take place annually in mid-May and early August in order to reveal the vegetation composition and the degree of flowering. Walkover inspections will be carried out at regular intervals (approximately every month) in order to monitor grazing and the development of vegetation throughout the year.

The lands outside of the areas of salt marsh habitats at Mweeloon comprise coastal grassland. These areas will be subject to the same grazing regimes which will benefit the vegetation of the area.

10.Compensatory Measures

The Compensatory Measures for the GHE comprise:

- Intertidal Management Plan at Mweeloon (see **Table 10.1**), and,
- Land Management Plans at Tawin West (see **Table 10.2**).

Table 10.1: Compensatory Measures at Mweeloon for the Intertidal habitat

Measure	
1	**Control of *Didemnum*** Carry out on an on-going basis a programme to control the colonial non-native tunicate [marine invertebrate] *Didemnum vexillum* at Mweeloon Lagoon.
2	**Repair/ Maintain Fences and Gates** GHC will repair/ maintain fences and gates along the boundary of the land purchase areas in the Mweeloon Compensatory Area to prevent trespass. As GHC will own the land, it will put padlocks on external gates and only allow individuals who lease the land for agricultural purposes access to them, thereby preventing any potential for removal of cobbles *etc*. in the future.
3	**Signage** Information signs will also be erected at selected locations along the site boundaries to inform the public of the objective of the project and warn against trespass and the removal of material from the shore.
4	**Cease Construction of Drainage Channels** Prevent the construction of and cease the maintenance of any land drainage channels.
5	**Cease Aquaculture** Complete the purchase of the control of licences for aquaculture on the foreshore within 3 months of F.G.S.P. with a view to removing the oyster trestles within 12 months and on a permanent basis, resulting in a permanent fallowing of aquaculture operations at these particular sites.
6	**Control Tractor Access** Tractors are used to access the aquaculture installations over Intertidal areas and in doing so, they damage algae and both epibenthic and infaunal species. Tractor access will be controlled by: • The fallowing of aquaculture will reduce tractor use, • Restricting access route to along the highest part of the shoreline but below the stony bank habitat as per aquaculture licences, • Tractor access will only be required for remaining active aquaculture licenced areas.
7	**Nature friendly Farming Practices** The implementation of “nature friendly” farming practices that besides having beneficial effect on terrestrial habitats, may also have beneficial effect on intertidal marine ecology. These measures include: controls on the use of anthelmintic drugs with expiry of the withdrawal period before treated livestock are brought onto the lands at Mweeloon, no herbicide and no fertiliser.
8	**Removal of anthropogenic litter and rubbish** Regular removal of anthropogenic litter and rubbish. Removal will occur every 3 months and directly after a Force 9 or greater storm event. Litter and rubbish will be removed to recycling / licensed disposal site.

Measure	
9	**Annual Review of the implementation of the Compensatory Measures Plan will be undertaken** Annual Reports on the Implementation of the Compensatory Measures Plan will be prepared and submitted to the Planning Authority and to NPWS/ DHLGH. The Annual Report will include a section describing monitoring activities, results and any recommendations arising for the adaptation of the Compensatory Measures, in view of the monitoring results. It is proposed that Annual Meetings with the Planning Authority and NPWS/DHLGH will be convened to discuss the Annual Reports and any modifications/ adaptations that are recommended, for their approval. If matters of significance arise in the intervening months that may warrant more immediate amendment of a compensatory measure, approval of same will be sought by correspondence or by an extraordinary meeting, the latter on request. **Compensatory Measures Plan Implementation** It is expected that the implementation of the CMP will be overseen by Galway City Council ("GCC") as the planning authority for the Galway Harbour Extension The envisaged implementation approach is that an annual report will be prepared by Galway Harbour Company ("GHC") and their specialist team in relation to the monitoring and management of the compensatory measures areas, adjacent areas of accompanying measures and additional environmental benefits, all in line with the CMP. This annual report will be submitted to GCC. The planning authority (GCC) is expected to determine the methodology and procedures for implementation, including the circulation of the annual report to the relevant stakeholders, one of which will be NPWS, and perhaps Galway County Council and others as GCC consider appropriate. It is envisaged that the implementation will include an annual meeting of all of the stakeholders, including GHC, and will allow for more frequent meetings if required. The implementation is expected to include site visits at appropriate seasonal times by the relevant stakeholders. For example, there may be a site visits in early Spring and again in September before and after the appropriate growing seasons on the lands. The annual report will then be submitted to GCC before the year end in order to allow time for GCC, NPWS and other relevant stakeholders to review the findings and make recommendations as required ahead of the next spring season.

Table 10.2: Compensatory Measures at Tawin West for stony bank

Measure	
1	**Repair/ Maintain Fences and Gates** GHC will erect / maintain a fence and 2 gates along the boundary of the land purchase area in the Tawin West Compensatory Area and repair / maintain the existing fences / stone walls on the seaward boundary and boundaries with adjacent lands to prevent trespass and control stock. As GHC will own the land, it will put padlocks on external gates and only allow individuals who lease the land for agricultural purposes access to them, thereby preventing any potential for removal of cobbles etc. in the future.
2	**Signage** Information signs will be erected at selected locations along the site boundaries to inform the public of the objective of the project and warn against trespass and the removal of material from the shore.

3	**Grazing** Regulating grazing will reduce overgrazing and dunging and to a lesser extent, poaching of the habitat. There will be no grazing between the 1st of April and the 31st of August. A light grazing regime will be implemented between the 1st of September and the 31st of March at grazing intensity of between 0.5 to 1.0 LU per hectare. These measures will promote the flowering/ seed set and growth of plant species which will benefit insect species. The lands outside of the areas of stony bank habitats within the Compensatory Area at Tawin West comprise coastal grassland and salt marsh habitat. These areas will be subject to the grazing regime outlined above which will benefit both the vegetation and birds of the area. Walkover inspections will be carried out at regular intervals (approximately every month) in order to monitor grazing and the development of vegetation throughout the year. This will ensure that potential problems such as localized poaching will be identified at an early stage and the appropriate management measures can be taken.
4	**Inspections** Walkover inspections to be carried out at regular intervals (approximately every month) in order to monitor grazing and the development of vegetation throughout the year. This will ensure that potential problems such as localized poaching will be identified at an early stage and the appropriate management measures can be taken.
5	**Control Use of Anthelmintic Drugs** Animals to be brought onto the lands will be treated in advance so that they will be outside of the recommended anthelmintic 28 day withdrawal periods.
6	**Control Vehicle Access** By minimizing tractor access and confining unavoidable access to very limited occasions *e.g.* removal of sick or dying livestock.
7	**Nature friendly Farming Practices** The implementation of "nature friendly" farming practices that besides having beneficial effect on terrestrial habitats, may also have beneficial effect on intertidal marine ecology.
8	**Herbicide** Cease use of herbicide.
9	**Fertilizer** Cease the use of fertilizer on the lands and reduce dunging in this habitat by repair of animal fencing. By ceasing fertilizing and supplementary feeding on the lands, the stony bank areas will return to a natural state and nitrogen and phosphorous soil contents will return to natural levels.
10	**Eliminate winter and supplementary feeding** Eliminate winter feeding of livestock and supplementary feeding and specifically the use of ring feeders. This will stop related poaching and rutting of lands at feeding sites and around gates. However, should it become apparent that grazing animals are losing condition before the site has been grazed to an optimal level, options for nutritional supplements may be considered for the welfare of the livestock. Any proposal to permit supplementary feed on the site must be agreed in writing with NPWS/ DHLGH.
11	**Removal of anthropogenic litter and rubbish** Regular removal of anthropogenic litter and rubbish. Removal will occur every 3 months and directly after a Force 9 or greater storm event. Litter and rubbish will be removed to recycling / licensed disposal site.

12	**Surveys** Annual survey to be undertaken will monitor stony bank and salt marsh vegetation at Tawin West. The results/observations of these surveys will inform ongoing habitat management. Monitoring surveys will follow the approach outlined in Martin *et al.* (2017) and McCorry and Ryle (2009). Long-term tide level monitoring to be conducted using water level recorders in the anchialine pool area at Tawin west.
13	**Turf stripping** This method may be used over small areas, typically <1 sqm, to remove small dense patches of agricultural grass species, such as *Lolium perenne*. Stripping of the vegetation would expose a shallow stony, dry soil which would favour the colonization and growth of a more natural stony bank flora. No turf stripping will be undertaken without the prior agreement of NPWS/ DHLGH.
14	In recognition of local concerns that a breach of the stony banks, within the compensatory measures area, may occur that would result in flooding damage to local homes, consideration is to be given to appropriate long term protection measures that would not affect the Conservation Objectives of the SAC. If a breach in the stony bank occurs, management actions *i.e.* sensitive reconstruction of the stony bank that will have no long term negative effects on site mobility and the Conservation Objectives may be considered as a temporary short-term measure, subject to agreement with NPWS/DHLGH. The detailed long-term monitoring and assessments of the existing geological features and habitats which will be undertaken will establish the potential implications of the management options on the site. Management actions will be subject to appropriate approvals with input provided by NPWS. Any medium-longer term proposed management actions will be submitted to the Planning Authority and NPWS/DHGLG as part of the Annual Review process. Depending on the nature of the proposed management actions, statutory approvals may also be required, such as planning permission or Ministerial Consent, all of which are subject to the requirements of the Habitats Directive, including appropriate assessment.

15	**Annual Review of the implementation of the Compensatory Measures Plan will be undertaken** Annual Reports on the Implementation of the Compensatory Measures Plan will be prepared and submitted to the Planning Authority and to NPWS/ DHLGH. The Annual Report will include a section describing monitoring activities, results and any recommendations arising for the adaptation of the Compensatory Measures, in view of the monitoring results. It is proposed that Annual Meetings with the Planning Authority and NPWS/DHLGH will be convened to discuss the Annual Reports and any modifications/ adaptations that are recommended, for their approval. If matters of significance arise in the intervening months that may warrant more immediate amendment of a compensatory measure, approval of same will be sought by correspondence or by an extraordinary meeting, the latter on request. **Compensatory Measures Plan Implementation** It is expected that the implementation of the CMP will be overseen by Galway City Council ("GCC") as the planning authority for the Galway Harbour Extension The envisaged implementation approach is that an annual report will be prepared by Galway Harbour Company ("GHC") and their specialist team in relation to the monitoring and management of the compensatory measures areas, adjacent areas of accompanying measures and additional environmental benefits, all in line with the CMP. This annual report will be submitted to GCC. The planning authority (GCC) is expected to determine the methodology and procedures for implementation, including the circulation of the annual report to the relevant stakeholders, one of which will be NPWS, and perhaps Galway County Council and others as GCC consider appropriate. It is envisaged that the implementation will include an annual meeting of all of the stakeholders, including GHC, and will allow for more frequent meetings if required. The implementation is expected to include site visits at appropriate seasonal times by the relevant stakeholders. For example, there may be a site visits in early Spring and again in September before and after the appropriate growing seasons on the lands. The annual report will then be submitted to GCC before the year end in order to allow time for GCC, NPWS and other relevant stakeholders to review the findings and make recommendations as required ahead of the next spring season.

11. NPWS Consultation Requests - Tawin West

During consultation meetings NPWS requested GHC to undertake a series of surveys at Tawin West and commission a technical note on coastal erosion and flood risk in the area; responses to address these requests are presented in **Section 11.1** and **Section 11.2** below.

11.1. Survey of Stony Bank Vegetation at Tawin West

11.1.1. Introduction

This section describes the vegetation of an area of stony bank habitat on Tawin Island, Co. Galway. The area has been identified as a location where management measures could be conducted in order to compensate for the sheltering effect of the proposed Galway Harbour extension on an area of stony bank habitat at Renmore, Galway. The survey area, which is located in the townland of Tawin West, comprises an area of vegetated stony bank habitat (Photograph 1 below) occurring on a south-facing slope along the north-western shore of Tawin island (Grid reference M 309195). The stony bank area measures approximately 310 metres long and the width varies between 15 and 50 metres, with a total area of approximately 1.1 hectares. Limestone shingle shoreline adjoins to the north and to the south the habitat grades into coastal grassland on flat ground dominated by *Festuca rubra*, *Agrostis stolonifera* and the moss *Rhytidiadelphus squarrosus*. Further to the south there is a shallow saline waterbody, fringed by salt marsh vegetation, which is subject to tidal influence via an underground hydrological connection.

The substrate of the stony bank area comprises a shallow (5 to 15cm), mineral-rich organic soil which overlies rounded limestone shingle. The stony bank area and adjoining salt marsh are grazed by livestock and grazing has been intensive in the past. As a result of this history of relatively intensive management the stony bank vegetation contains a high cover of weedy grassland species. This survey documents and assesses the vegetation composition of the stony bank habitat which occurs and outlines a number of measures to improve the botanical composition and condition of the vegetation.

Photograph 1. General view of semi-improved vegetated stony bank vegetated at Tawin, looking to the north-east.

11.1.2. Results

A field survey was carried out on the February 11th 2022. Whilst this is early in the year for carrying out vegetation surveys in coastal habitats the majority of the plant species occurring can be readily recognized. The vegetation is described along five transects oriented in a north-west to south-east direction, running from the northern edge of the vegetated stony bank to the adjoining coastal grassland vegetation which occurs on flatter terrain to the south. Each transect contained four plots in which the vegetation is recorded within a 2 x 2 metre area (also known as a relevé). A total of 16 relevés were recorded in areas of stony bank vegetation with 4 recorded in adjoining coastal grassland to the south. The main data recorded within the relevés is as follows:

- Relevé area
- Grid reference, recorded by GPS (Irish National Grid).
- Slope and aspect
- Percentage cover of vegetation, bare soil, water and stone, in accordance with the following scale ≤1%, 3%, 5%, 8%, 10% and subsequently to the nearest 10%.
- Percentage cover of vascular plant and moss species present, in accordance with the following scale ≤1%, 3%, 5%, 7%, 10% and subsequently to the nearest 10%.
- Percentage cover and height of the different vegetation layers*, i.e.* shrub, herb and bryophyte.
- Soil type and depth
- Additional details, such as the composition of the surrounding vegetation, degree of grazing, evidence of dunging, habitat disturbance, *etc*.
- The composition and quality of the habitat vegetation is assessed in accordance with the criteria outlined in Martin *et al*. (2017).

Photograph 2. View of a relevé being recorded on stony bank vegetation at Tawin West.

No rare plant species were recorded within the survey area however *Glaucium flavum* (Yellow horned-poppy) was noted growing in areas of stony bank habitat immediately to the east and west of the survey area. This species is considered to be declining in Ireland (Wyse Jackson *et al.* 2016) and Tawin Island is the most northerly known location for the species on the west coast of Ireland (BSBI maps).

The vegetation also contains a number of plant species which are considered to be typical of improved agricultural conditions, most notably *Cirsium vulgare* (Spear thistle), *Lolium perenne* (Perennial rye-grass) and *Urtica dioica* (Common nettle). From a conservation assessment point of view these species are termed 'Negative species'. In addition, it is considered likely that the cover of the negative weedy species *Cirsium arvense* (Creeping thistle) has been underestimated as the species completely dies back during the winter months. It is also noted that species indicative of semi-improved grassland habitats such as *Cynosurus cristatus* (Crested dog's-tail), *Cerastium* (Chickweed species), *Dactylis glomerata* (Cocks foot) and *Holcus lanatus* (Yorkshire fog) occur albeit at a lower cover.

The negative species *Cirsium vulgare* was recorded from 87% of the stony bank relevés (Average cover of 6%, range 0 to 15%) and the agricultural grass species *Lolium perenne* was recorded from 66% of the stony bank relevés (Average cover of 4.7%, range 0 to 15%). The negative species *Urtica dioica* (Common nettle) was recorded from two of the relevés at a very low cover. As *Lolium perenne* and *Cirsium vulgare* are present in more than 60% of the relevés the site fails the structure and functions assessment for the habitat on the basis of the presence of negative indicator species criteria. This results in an unfavourable-Inadequate ranking for the structure and functions criteria of the stony bank habitat at the site.

A follow-up visit to the site was conducted on the 3rd of June 2022. Observations during this visit suggest that the cover of *Lolium perenne* is generally higher than that noted during the February survey. In addition, the widespread occurrence of the grass *Bromus hordeaceus* (Soft brome) was noted in June. This species is indicative of semi-improved grassland habitat.

11.1.3. Conclusions

This survey has demonstrated that the stony bank vegetation which occurs at Tawin West has a high cover of negative agricultural/weed species which results in a lowering of the ecological quality of the habitat.

In view of this finding it would be ecologically desirable to reduce the distribution and cover of this group of plant species. This reduction will be achieved by a number of management options which are as follows:

(1) Reduction of the grazing intensity

A reduction in grazing intensity will reduce the incidence of poaching and dunging by herbivores and will also result in an increase in the flowering of grasses and forbs which would be beneficial to insects. The lack of disturbance resulting from the exclusion of livestock during the bird breeding season could also benefit bird breeding.

The reduction in nutrient inputs will over time lead to a decline of more nutrient demanding plant species such as *Lolium perenne* and *Urtica dioica*. A reduction in poaching levels will also lead to a decline in bare soil area and thus reduce the germination opportunities for biennial/perennial weed species such as *Cirsium vulgare* and *Cirsium arvense*.

(2) Turf stripping

This method may be used over small areas, typically <1sqm, to remove small dense patches of agricultural grass species, such as *Lolium perenne*. Stripping of the vegetation would expose a shallow stony, dry soil which would favour the colonization and growth of a more natural stony bank flora.

Table 11.1: Relevés from stony bank vegetation and coastal grassland vegetation at Tawin West.

Relevé Code	**A1**	**A2**	**A3**	**B1**	**B2**	**B3**	**C1**	**C2**	**C3**	**D1**
Location	stony bank	stony bank	stony bank	stony bank	stony bank	stony bank	stony bank	stony bank	stony bank	stony bank
Grid easting	M 30808	M 30800	M 30803	M 30849	M 30857	M 30862	M 30902	M 30907	M 30918	M 30970
Grid northing	19500	19486	19479	19534	19529	19520	19569	19566	19566	19587
Slope (Degrees)	10 to 15	10 to 15	5 to 15	5 to 15	15 to 25	10 to 20	10 to 20	20 to 30	15 to 25	5 to 15
Soil depth (cm)	5 to 10	5 to 10	5 to 10	5 to 15	5 to 15	5 to 10	1 to 10	0 to 15	0 to 5	3 to 5
Quadrat size (m)	4	4	4	4	4	4	4	4	4	4
Vegetation cover (%)	97	100	100	100	100	100	95	98	95	100
Bare rock (%)	0	0	0	0	0	0	5	2	5	1
Dung (%)	3	0	0	0	0	0	0	0	0	0
Shrub cover (%)	0	0	0	0	0	0	0	0	0	0
Herb cover (%)	80	65	60	55	60	70	50	65	45	80
Bryophyte cover (%)	50	45	50	70	65	60	75	65	75	30
Vegetation height (cm)	10 to 15	5 to 10	5 to 15	10 to 15	5 to 10	5 to 15	5 to 10	5 to 15	5 to 10	5 to 10
No. of species	12	14	13	12	13	12	14	16	10	16
Festuca rubra	30	30	30	20	15	20	15	25	20	20
Agrostis sp.	30	25	20	10	15	10	3	10	5	15
Rhytidiadelphus squarrosus	50	40	45	65	60	55	75	65	70	30
Poa pratensis	5	10	10	10	5	25	10	8	3	10
Trifolium repens	3	3	5	5	5	10	5	3	10	3
Taraxacum officinale	1	3	5	5	5	5	3	8		10

Cirsium vulgare	10	3	10	10	3		15	5	5	
Plantago lanceolata	3		5	5	5	1	10	1	1	5
***Cerastium* sp.**		3					3	1	3	5
Bellis perennis	3			3	3		5	3		3
Cynosurus cristatus			5	3	10	5		5		3
Lolium perenne		10	5	3	5		1	3		3
Geranium molle	1								3	1
Brachythecium albicans		3	1	3	3	3				
Dactylis glomerata	3	15			3			3		
Scorzoneroides autumnalis	1	3	3				1	1		
Kindbergia praelonga		5				1				
Urtica dioica		3								
Luzula campestris			1	3						
Homalothecium lutescens							1	1	3	3
Achillea millefolium								1		1
Holcus lanatus										3
Potentilla anserina										3
Cirsium arvense						1				
Lotus corniculatus							1			
Scleropodium purum										

Table 11.2: Relevés from stony Bank vegetation and coastal grassland vegetation at Tawin West

Relevé Code	**D2**	**D3**	**E1**	**E2**	**E3**	**E4**	**A4**	**B4**	**C4**	**D4**
Location	stony bank	stony bank	stony bank	stony bank	stony bank	Coastal grass	Coastal Grass	Coastal Grass	Coastal Grass	Coastal Grass
Grid easting	M 30972	M 30981	M 31036	M 31028	M 31042	M 31044	M 30811	M 30875	M 30926	M 30985
Grid northing	19579	19569	19610	19599	19598	19581	19454	19502	19545	19550
Slope (Degrees)	5 to 15	5 to 15	10 to 15	10 to 15	5 to 15	<3	<3	<3	<5	5 to 15
Soil depth (cm)	3 to 5	3 to 10	1 to 3	1 to 3	1 to 3	10 to 15	5 to 15	5 to 15	10 to 18	5 to 10
Quadrat size (m)	4	4	4	4	4	4	4	4	4	4
Vegetation cover (%)	100	100	98	98	100	100	95	90	100	100
Bare rock (%)	1	0	1	0	0	0	0	0	0	0
Dung (%)	0	0	5	3	0	0	5	10	0	0
Shrub cover (%)	0	0	0	0	0	0	0	0	0	0
Herb cover (%)	75	60	75	70	80	90	75	75	95	80
Bryophyte cover (%)	35	75	50	35	35	60	65	40	15	60
Vegetation height (cm)	5 to 10	5 to 15	5 to 10	5 to 15	5 to 10	5 to 1o	5 to 10	5 to 15	5 to 15	10 to 20
No. of species	15	12	12	16	9	8	8	7	5	6
Festuca rubra	20	15	20	15	15	60	35	55	60	40
Agrostis sp.	15	10	15	10	10	25	25	10	30	30
Rhytidiadelphus squarrosus	35	75	50	25	35	60	60	35	15	60
Poa pratensis	3	5	10	8			10	5	3	10
Trifolium repens	3	15	5	5	5	3	1	3	3	5
Taraxacum officinale	10	5	5	5						

Cirsium vulgare	3	3	5	3	3					
Plantago lanceolata	10		3	8	5					
***Cerastium* sp.**	3	5	8	5	8	1	1			
Bellis perennis	5	5	10	5						
Cynosurus cristatus	10	10					3			
Lolium perenne			10	15	15	3				
Geranium molle		1	3	5						
Brachythecium albicans										
Dactylis glomerata										
Scorzoneroides autumnalis		1		1						
Kindbergia praelonga	1			5		3		5	1	
Urtica dioica										
Luzula campestris	3									
Homalothecium lutescens	3			3						
Achillea millefolium	1			1						
Holcus lanatus					15	1				3
Potentilla anserina								3		
Cirsium arvense										
Lotus corniculatus										
Scleropodium purum							3			

GHC has entered into binding agreements to purchase outright land holdings at Tawin West Compensatory Area (see **Figure 11-1**). Blake and Kenny Solicitors confirmation regarding the new Land Purchase Agreement (Tawin West) is included in Appendix D. As is the case for the land holdings at Mweeloon, once the development is permitted GHC will undertake the following at the lands at Tawin West:

- Repair/ maintain fences and gates along the boundary of the land purchase areas to prevent trespass.
- Secure external gates using padlocks and only allow individuals who lease the land for agricultural purposes access to them
- Erect information signs at selected locations along the site boundaries to inform the public of the project and warn against trespass and the removal of material from the shore.

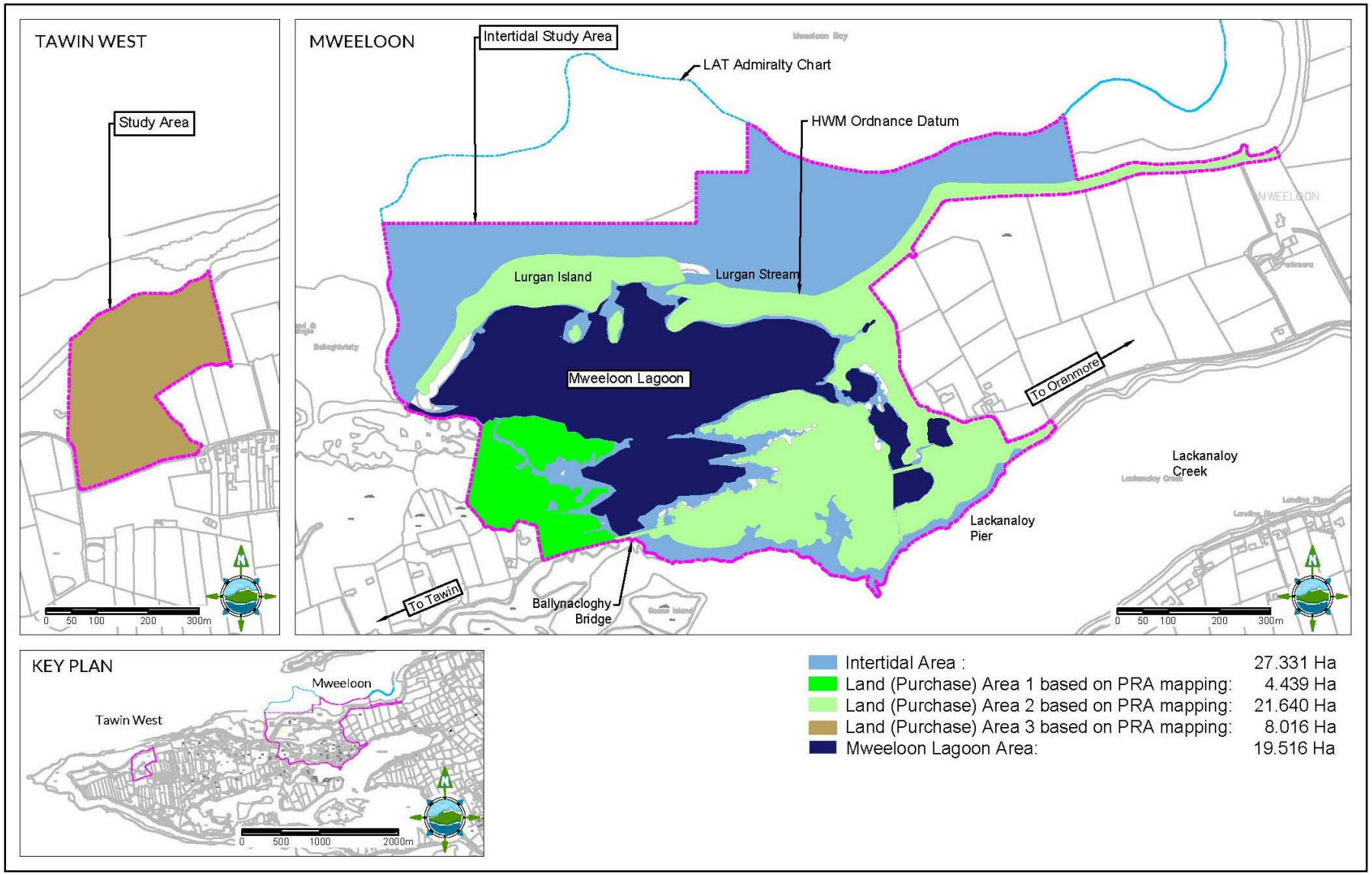


Figure 11-1: Land Purchase Areas at Mweeloon and Tawin West.

11.2. Coastal Erosion and Flood Risk at Tawin West and Implications for the Proposed Habitat Compensatory Measure Lands

This section is prepared by Dr. Anthony Cawley, Hydro Environmental Ltd and presents a technical note in Sections 11.2.1 to 11.2.5 inclusive concluding with Figure 11-7.

11.2.1. Introduction

As part of the habitat Compensatory Measures for the GHE Project, designated SAC lands located on the northside of Tawin Island are to be purchased for habitat management and protection. These lands are *circa* 8 ha in area and are located between the shoreline and the Tawin Island residential settlement area. This assessment considers the current flood risk and erosion pressures to the residents at Tawin Island and the stony bank shoreline area in the vicinity of the proposed compensatory measure lands. **Figure 11-2** below presents the general site location of Tawin West on Tawin Island.

Figure 11-2: General location of Compensatory Measures site at Tawin Island.

11.2.2. Physical Processes

The subject lands fall northwards from the Tawin old school house and local road at c. 3.5m to 4.0m OD to the low-lying subterraneanally tidally driven salt marsh section in the middle of the site refer to plate 1 at *circa* 1 to 1.5m OD and then rises at the stony bank shoreline with crest elevation along the stony bank of *circa* 4.0m to 4.2m OD, refer to Plates 2 and 3. The stony bank provides a barrier between the sea and the low-lying lands in the salt marsh area. Within the salt marsh area there are permanent elongated anchialine pools (a tidal driven pond feature) overlying limestone bedrock at bed levels of less than 0.5m OD, refer again to Plate 1. This salt marsh area has a tidal signal possibly via karst limestone bedrock and small karst spring connections with the sea. This tidal signal is damped and the full tidal range is not transmitted to the salt marsh area.

The stony bank shoreline at the site and on the lands to the west of the site is sufficiently raised to elevations above *circa* 4m OD to prevent tidal still water and normal wave overtopping.

The stony bank shoreline area to the east towards the disused pier is slightly lower and flatter in profile, refer to Plate 4 and has top elevations of *circa* 3.5mOD along this section. It therefore does not provide full protection against tidal still water overtopping and as a consequence provides a pathway for tidal waters to flood those low-lying lands behind that area of stony bank, and then laterally to adjacent lands. Such overtopping occurs only (particularly) at the more extreme tidal events and inundation from the occasional more extreme tides of greater than 3.5m OD (refer to Plate 4).

Further to the east are the breaches and lagoonal entrances which transmits flood waters into the low-lying lands behind those stony banks which makes a sub island of Tawin West in such high tidal circumstances.

The GSI Infomar lidar dataset provides lidar data for this area surveyed in 2006 with reported accuracy of ±200mm in the vertical. A recent topographical survey of the subject lands as part of the compensatory lands assessments was carried out in January 2022. A contour map using the topographical data is presented in Figure 2 with the lidar data used for the adjacent lands. A transverse section across the site is presented in Figure 3 which shows the lower marsh area and the stony bank profile.

The shingle barrier along the shoreline at the site is reasonably stable and consistent, based on a walkover inspection with only relatively minor sites of local erosion identified at two locations refer to plate 5. A comparison between the shoreline boundary using its highwater mark between the current OSI map and the first edition OSI mapping indicates little or no significant evidence of shoreline retreat. The minor sites of erosion are relatively local and not considered a significant risk to the integrity of the stony bank barrier at the site. A pathway is evident along the stony bank produced by livestock and walkers which potentially increases the vulnerability of these local sites of erosion.

A significant site of bank erosion is located 600m to the east of the subject lands where a complete breach in the stony banks has occurred. It appears that rock armour protection had been placed in the past to limit the erosion but this rock armour protection has failed having been undermined and lowered through the wash-out of fines at the site, refer to Plate 6.

Another site of potentially significant stony bank erosion is located on the lands immediately to the west of the site where the bank appears to have retreated and is displaying significant erosion from wave action, refer to Plate 7. Significant shingle deposition by storm waves is also evident further to the west of this location, refer to Plate 8.

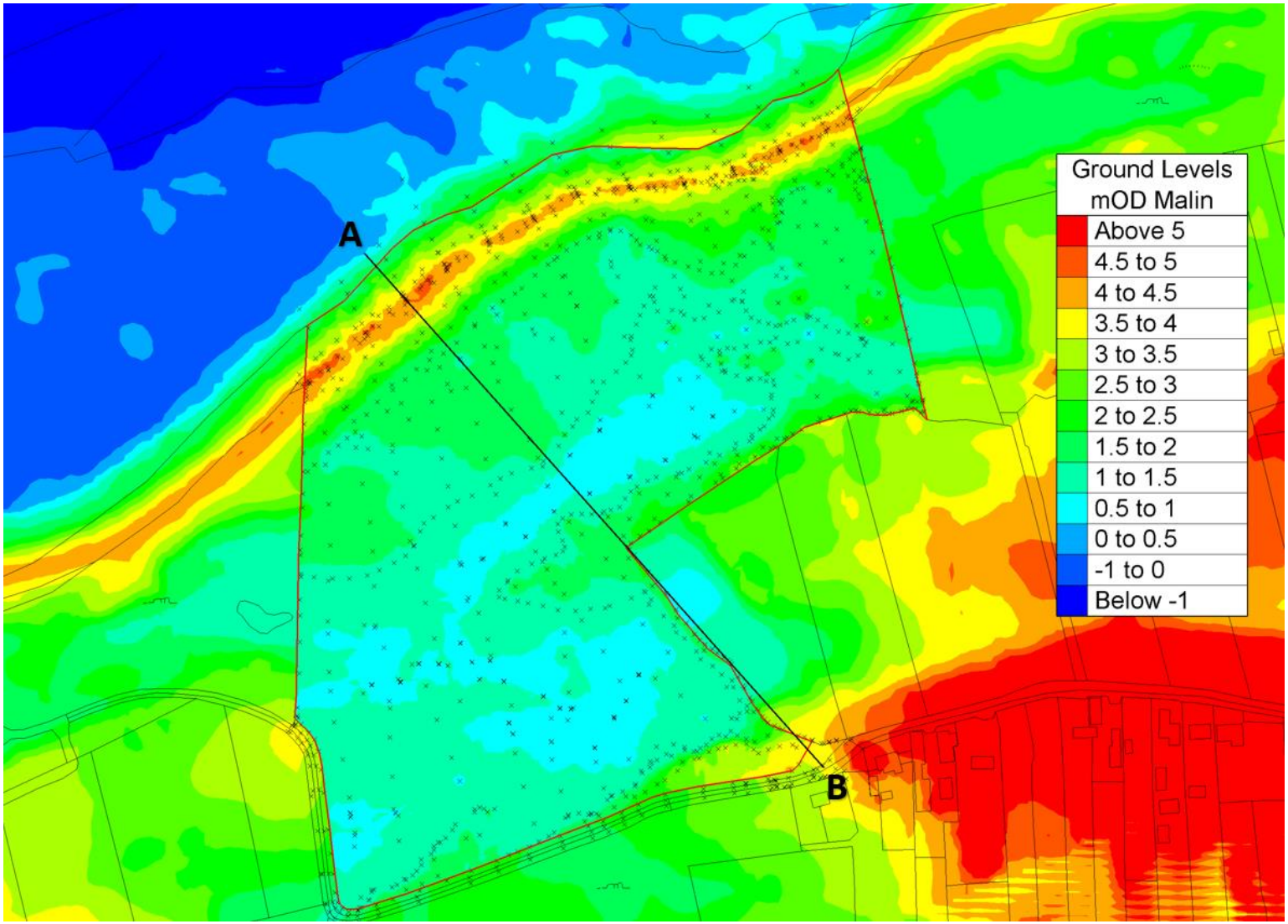


Figure 11-3: Contour map of site from recent topographic survey.

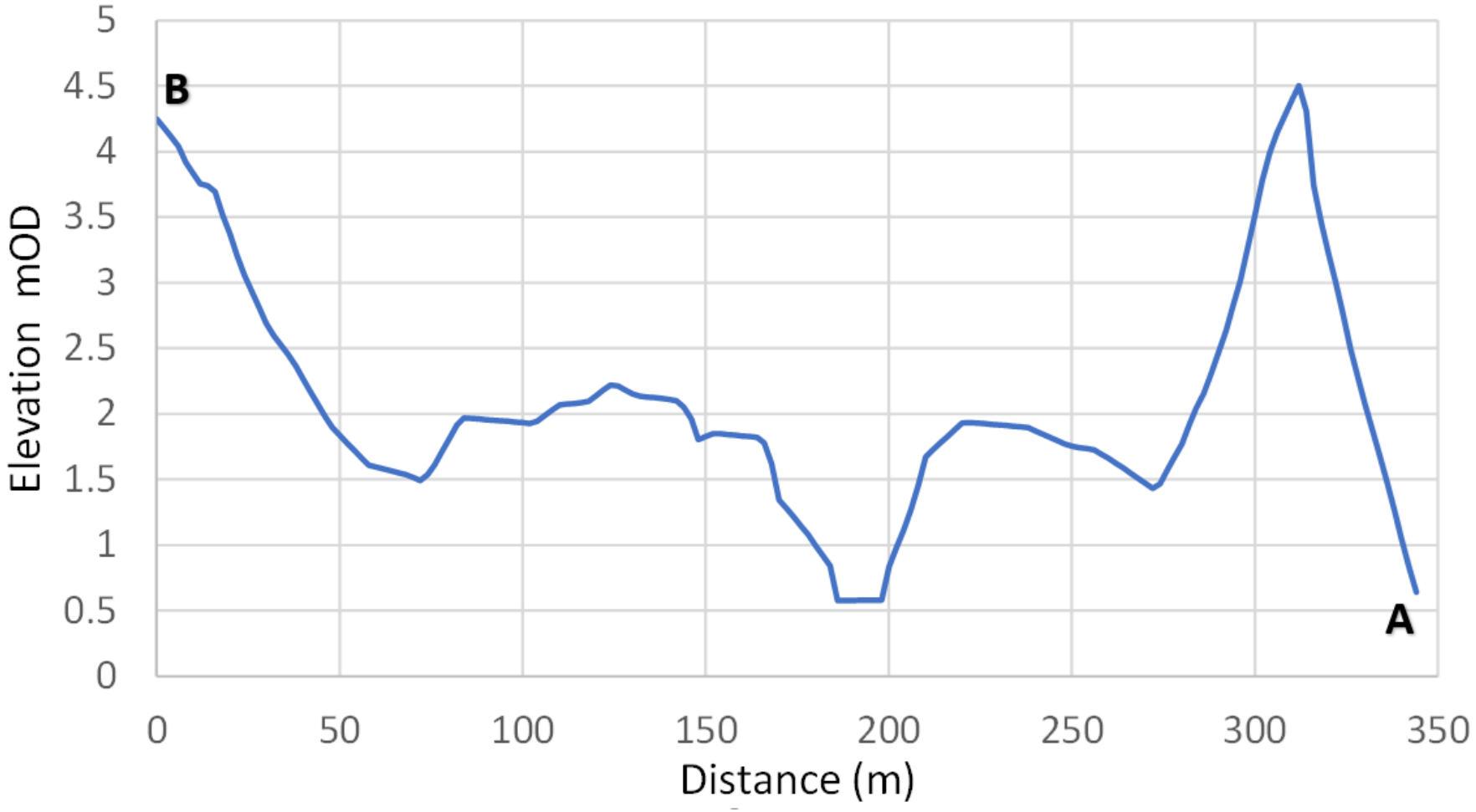


Figure 11-4: Transverse section through site.

Figure 11-5: Current sites of significant stony bank erosion.

Plate 1. View of elongate anchialine pool (a tidal driven pond feature) looking southeast towards the settlement on Tawin Island.

Plate 2. Stony bank Barrier at Site from salt marsh looking northwards.

Plate 3. Stony bank Barrier view long top of bank looking eastward at 3.5 to 4m OD Malin.

Plate 4. Flatter Lower Section of Stony bank to the east of the subject lands with elevations at circa 3 to 3.5m OD.

Plate 5. Local Site of erosion on stony bank at subject lands.

Plate 6. Significant site of bank erosion 600m to the east of the subject lands where rock armour protection had been placed previously (late 90's) but has been undermined and significantly lowered forming ineffective protection.

Plate 7. Significant local Bank Erosion 80m west of the subject lands.

Plate 8. More active section of stony bank with single deposition from storms located 150m from subject lands.

11.2.3. Flood Risk

The latest Irish Coastal Wave and Water level study (ICWWS, OPW 2020) predicts a 10year tidal flood peak level of 3.56m OD, a 200year tidal Flood level of 4.01m OD and a 1000year flood level of 4.24mOD near Tawin Island, which are slightly higher than the previous Irish Coastal Protection Strategic Study (ICPSS, 2012) predictions by between 0.23 to 0.25m. The flood mapping extent for the 200year tidal flood event is presented in Figure 5 and 6 below. This mapping shows the Tawin West Island completely cut-off, a number of dwellings flooded and the tidal inundation surrounding the higher ground settlement area from all sides.

Under the more extreme tidal flood events of 50year and greater return period the stony bank shoreline generally at Tawin west will not provide effective protection against flooding with tidal waters exceeding the crest level over large sections of the bank, particularly along the southern shoreline area of the island and for large sections of shoreline area on the northside of the island, further to the east of the subject lands. Such extensive length of overtopping during these events will easily exhaust the available flood storage within the low-lying lands behind stony bank producing flood levels at the settlement areas similar to the open sea.

The stony banks do provide moderate protection against storm wave overtopping and under those particular conditions provides an effective buffer in combination with the low-lying salt marsh storage lands. Development of breaches in the stony bank as a result of wave action can result in significant changes to the dynamics of the salt marsh and lagoonal areas behind the stony banks.

Currently the stony bank along the subject lands is not showing evidence of significant risk of erosion but the lands immediately to the west of the site are at considerably higher risk of bank erosion that could eventually lead to a potential breach.

With predicted sea level rise and increased severity and frequency of storm events coastal erosion and flood risk is likely to significantly worsen in the medium term, increasing significantly the flood risk exposure to the settlement on Tawin Island. Sea level rise will increase the duration and frequency of periods each year during which the Island has its vehicular access cut off.

Any medium-longer term proposed management actions will be submitted to the Planning Authority and NPWS/DHGLG as part of the Annual Review process. Depending on the nature of the proposed management actions, statutory approvals may also be required, such as planning permission or Ministerial Consent, all of which are subject to the requirements of the Habitats Directive, including appropriate assessment.

If a sudden breach in the stony bank occurs, management actions *i.e.* sensitive reconstruction of the stony bank that will have no long-term negative effects on site mobility and the conservation objectives of the SAC may be considered as a temporary short-term measure, subject to agreement with NPWS/DHLGH.

11.2.4. Further Studies and Monitoring

In order to support the management of flood risk at the site detailed long-term monitoring and assessments of the existing geological features and habitats on the site will be undertaken. These baseline surveys will establish the potential for breaching of the stony banks at the site and the development of suitable management options to prevent / limit impacts on local houses that will have no long-term negative effects on site mobility and the conservation objectives of the SAC.

Annual and post storm monitoring will record erosion and accretion along the stony bank shoreline through topographical and photographic surveys to identify and map morphological changes in the stony bank. This monitoring will enable the tracking of changes to the bank and potential for erosion sites to develop or worsen that may indicate an increased risk of flooding to local houses. It will also record the natural effect of the casting ashore of shingle and cobble which may guide interim management of these

lands. These future assessment and monitoring studies will involve regular detailed shoreline topographical surveys and bathymetric surveys, possibly establishing fixed baseline survey transects to be set out, performing of detailed hydrodynamic and sediment transport modelling studies of the local and wider area, sediment sampling and distribution analysis, storm event analysis and the possible seeding of tracer sediments to identify and track movement of the shingle. It is also recommended that long-term water level monitoring within the salt marsh lake area be conducted involving the installation of water level recorder.

11.2.5. Conclusions

In conclusion the major flood risk to the settlement area on Tawin Island is from extreme tidal flood levels, against which the stony bank does not provide very effective protection, with significant length of shoreline area around the island well below the predicted 200year tidal level and therefore pervious to such flood levels and inundation.

The stony bank at the subject lands is reasonably stable and provides an effective barrier against tidal flood levels and wave runup with the crest level of the stony bank, based on the recent topographical survey, above 4m OD.

Two local, minor sites of erosion have been identified and these will be monitored annually and possibly protected from livestock and human traffic, which may potentially exacerbate these sites as it prevents vegetative ground cover.

The stony bank to the west of the subject lands is more vulnerable to erosion and could potentially be under threat from wave overtopping and potential breach in the medium term.

In terms of flood risk a breach scenario to the stony bank is likely to impact more on the available flood storage capacity of the lower lands behind the stony bank, thus increasing the flood risk to the existing lands and dwelling houses on Tawin Island.

Climate change particularly increased sea level rise of 0.5 to 1m over the next 100years represents a major problem for the existing settlements on Tawin Island and will result in potential extreme tidal levels reaching 5m OD which would not be easy to be defended against for many of the vulnerable properties. Given the low-lying and exposed nature of the location, the range of options available for long term adaptation to extreme tidal events must be considered.

In recognition of local concerns that a breach of the stony banks, within the Compensatory Measures area at Tawin may occur that could result in flooding damage to local homes, options for appropriate protection for the houses will be explored with the relevant stakeholders.

In order to support the management of flood risk at the site detailed long-term monitoring and assessments of the existing geological features and habitats on the site will be undertaken. These baseline surveys will establish the potential for breaching of the stony banks at the site and the development of suitable management options to prevent / limit impacts on local houses that will have no long-term negative effects on site mobility and the conservation objectives of the SAC.

Any medium-longer term proposed management actions will be submitted to the Planning Authority and NPWS/DHGLG as part of the Annual Review process. Depending on the nature of the proposed management actions, statutory approvals may also be required, such as planning permission or Ministerial Consent, all of which are subject to the requirements of the Habitats Directive, including appropriate assessment.

If a sudden breach in the stony bank occurs, management actions *i.e.* sensitive reconstruction of the stony bank that will have no long-term negative effects on site mobility and the conservation objectives of the SAC may be considered as a temporary short-term measure, subject to agreement with NPWS/DHLGH.

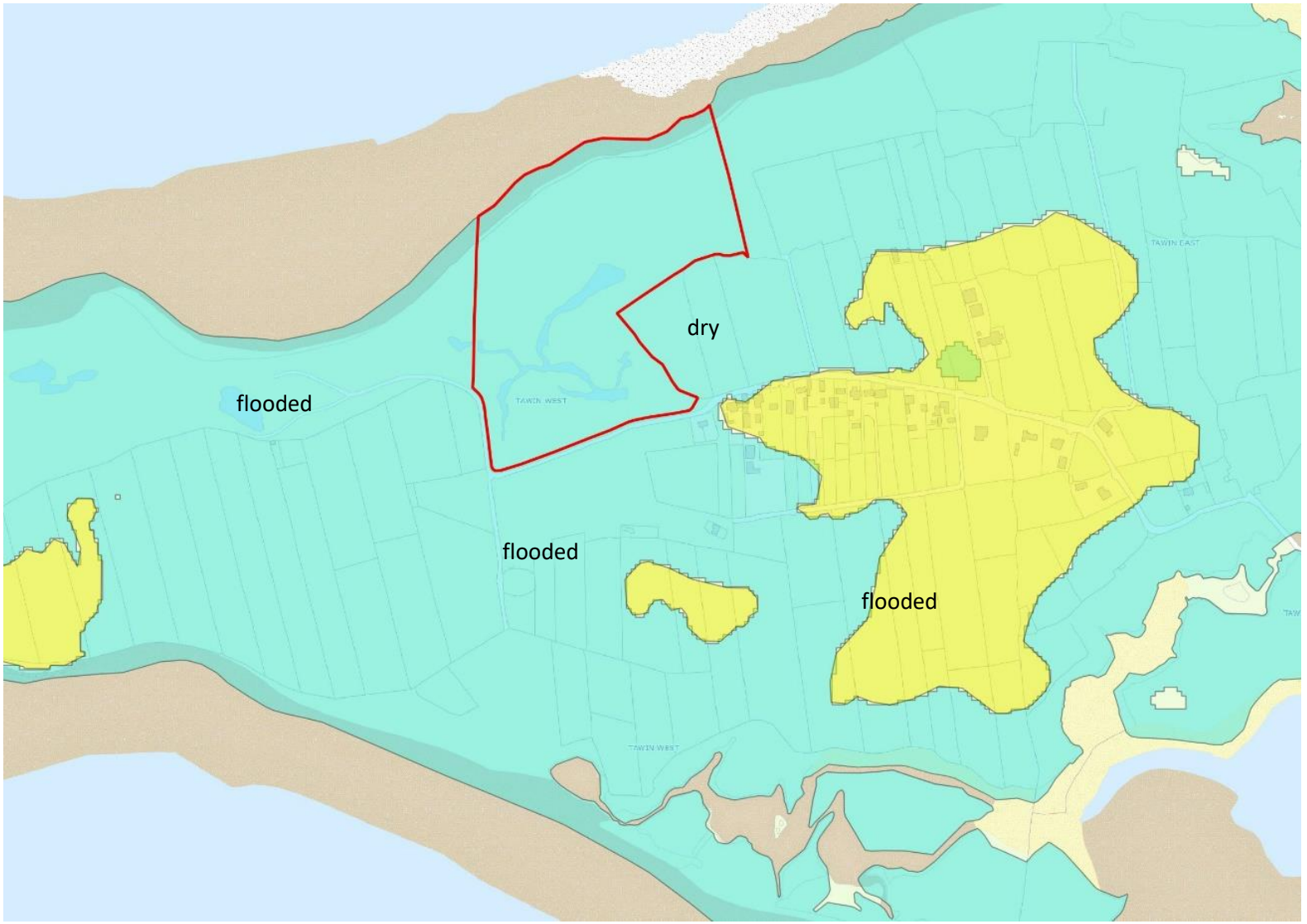


Figure 11-6. The 200year flood extent at Tawin Island showing settlement area surrounded by tidal waters and a number of dwellings within the flood extent.

Figure 11-7. Present day flood risk to the Greater Tawin Area highlighted in yellow.

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Appendix A

NPWS Letter (dated 3rd August 2021)

Our Ref: 61.PA0033
P.A.Reg.Ref:

Your Ref: JPK 7476-04-04

An Bord Pleanála

John P. Kelly
Tobin Consulting Engineers
Fairgreen House
Fairgreen Road
Galway

20th October 2021

Re:
Galway Harbour Extension
Renmore and Townparks Townlands, Galway

Dear Sir,

I have been asked by An Bord Pleanála to refer to the above-mentioned case.

The Board is of the opinion that in the particular circumstances of this case it is appropriate in the interests of justice to request you to make submissions or observations in relation to the enclosed submission received from the National Parks and Wildlife Service, which was forwarded to An Bord Pleanála by the Department of Housing, Planning and Local Government on the 3rd September, 2021.

Accordingly, you are requested to make any submissions or observations that you may have in relation to this enclosure. Any submission in response to this letter should be received by the Board not later than 5.30 p.m. on 18th November 2021.

If you have any queries in relation to the matter please contact the undersigned officer of the Board.

Yours faithfully,

pp. E. R.

Niamh Thornton
Executive Officer
Direct Line:01-8737247

Encl.

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Baile Átha Cliath 1
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64 Marlborough Street
Dublin 1
D01 V902

(f)

Eimear Reilly

From: Eimear Reilly
Sent: Tuesday 7 September 2021 14:50
To: Eimear Reilly
Subject: FW: Galway Harbour Extension - Your Ref: 61.PA0033
Attachments: ATP Scan In Progress

From: Niamh Thornton <n.thornton@pleanala.ie>
Sent: Tuesday 7 September 2021 10:21
To: Eimear Reilly <e.reilly@pleanala.ie>
Subject: FW: Galway Harbour Extension - Your Ref: 61.PA0033

From: SIDS <sids@pleanala.ie>
Sent: Tuesday 7 September 2021 10:20
To: Niamh Thornton <n.thornton@pleanala.ie>
Subject: FW: Galway Harbour Extension - Your Ref: 61.PA0033

From: Bord <bord@pleanala.ie>
Sent: Monday 6 September 2021 11:57
To: SIDS <sids@pleanala.ie>
Cc: Josephine Hayes <J.Hayes@pleanala.ie>
Subject: FW: Galway Harbour Extension - Your Ref: 61.PA0033

From: Housing Euplanningregulation <euplanningregulation@housing.gov.ie>
Sent: Friday 3 September 2021 16:27
To: Josephine Hayes <J.Hayes@pleanala.ie>
Cc: Bord <bord@pleanala.ie>; Eamonn Kelly (Housing) <Eamonn.Kelly@housing.gov.ie>; Declan Grehan (Housing) <Declan.Grehan@housing.gov.ie>
Subject: Re: Galway Harbour Extension - Your Ref: 61.PA0033

Dear Ms Hayes,

In response to your letter to the Minister dated 24 March 2021 re: Galway Harbour Extension (Your Ref: 61.PA0033), please find attached the letter from NPWS in relation to the proposed compensatory measures for Galway Port.

Kind regards

Tatiane Arantes
EU & International Planning Regulation

An Roinn Tithíochta, Rialtais Áitiúil agus Oidhreachta
Department of Housing, Local Government and Heritage

Teach an Chustaim, Baile Átha Cliath 1. D01 W6X0
Custom House, Custom House Quay, Dublin D01 W6X0

T +353 (0)1 888 2704 E tatiane.arantes@housing.gov.ie

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An Roinn Tithíochta,
Rialtais Áitiúil agus Oidhreachta
Department of Housing,
Local Government and Heritage

Ms Josephine Hayes,
Senior Executive Officer
An Bord Pleanála
64 Marlborough St, Rotunda,
Dublin 1

j.hayes@pleanala.ie

bord@pleanala.ie (Copied)

Sent by email only

3 September 2021

Re: Galway Harbour Extension - Your Ref: 61.PA0033

Dear Ms Hayes,

I am writing in response to your letter to the Minister dated 24 March 2021 concerning the Statement of Case submitted with that letter, outlining the Board's view that the proposed development should be granted for Imperative Reasons of Overriding Public Interest (IROPI).

In accordance with section 177AB(4) of the Planning and Development Act 2000, as amended, please be advised that we have received the attached letter from the NPWS, regarding the compensatory measures proposed in the **Galway Harbour Extension (IROPI) Planning Application**

I trust this clarifies the matter.

Yours sincerely,

Declan Grehan

Declan Grehan
Assistant Principal
EU & International Planning Regulation
Department of Housing, Local Government and Heritage

Teach an Chustaim, Baile Átha Cliath 1, D01W6X0
Custom House, Dublin 1, D01 W6X0
T +353 1 888 2561 | Declan.Grehan@housing.gov.ie
www.gov.ie/housing

Attachments: 1

An Roinn Tithíochta,
Rialtais Áitiúil agus Oidhreachta
Department of Housing,
Local Government and Heritage

Eamonn Kelly,
EU and International
Planning Regulation,
Department of Housing, Local
Government and Heritage,
Customs House,
Dublin 1.

3rd August 2021.

Re: Compensatory Measures for Galway Port Development

Dear Eamonn,

I write in relation to Minister O'Brien's request (26th March 2021) to Minister Catherin Martin, in accordance with section 177AB(1)(a) of the Planning and Development Act 2000, as amended ("the 2000 Act"), for views as to whether the compensatory measures proposed in **Galway Harbour Extension (IROPI) Planning Application, ABP Ref. 61. PA0003** are sufficient to ensure that the overall coherence of the Natura 2000 network is protected.

The proposed compensatory measures have been reviewed as to their adequacy. There are a number of proposed compensatory measures that are to be welcomed and that will contribute to the ongoing coherence of the Natura Network. However, there are questions outstanding as to the scale of the benefits that will arise from some measures, and the precise nature of the legal arrangements that are to be implemented to ensure long-term effectiveness and sustainability. Thus, NPWS will not be in a position to confirm their adequacy until such time as these matters are addressed.

The following matters need to be clearly addressed and stated within the proposed compensation package:

The Board's appropriate assessment concluded that compensation would be required for the following habitats as a result of the proposed development[1]:

[1] See Letter of 24th March 2021 from An Bord Pleanála to The Minister, Department of Housing, Local Government and Heritage: "The Board accepted and adopted the Appropriate Assessment carried out in the report of the Senior Planning Inspector and the specialist ecological consultant appointed by the Board in respect of the potential effects of the proposed development on the potentially affected European sites, having regard to the Sites' Conservation Objectives, namely that the integrity of the

- The direct and permanent loss of 5.93 ha of Intertidal habitat [1170] Fucoid Dominated Reef habitat and [1140] Mud and Sand Flat habitat in Galway Bay Complex SAC;

- The loss of perennial vegetation of 0.35 ha of stony banks [1220] due to the sheltering effect of the harbour extension, of which 0.2ha occurs within the SAC.

However, the Board's correspondence later states[2] that the integrity of Galway Bay Complex SAC will be also adversely affected because of the reclamation of land in the area carried out by the Galway Harbour Company in the mid-1990s to create the Galway Harbour Enterprise Park. The Compensatory Measures Report[3] has included proposed compensatory measures for the losses/effects arising on the SAC as a result of the development of the Galway Harbour Enterprise Park and these are to be welcomed. However, due to the differing statements within the Board's correspondence as to the effects arising on the SAC (alone and later, in combination), it is not entirely clear if views are sought as to the adequacy of the compensation measures in relation to adverse effects that will arise *solely* as a result of the proposed development (as referred to in the Letter), or in relation to adverse effects arising in *combination* with the earlier habitat losses that occurred (as referred to in the Appendix).

Request: Clarification is required before any final views or opinion may issue.

Perennial vegetation of Stony Banks:
NPWS' earlier observations (April 2020) stated the following:
"2. Sensitive Repair of existing sea defence wall
...However, the on-going issue of shingle removal, which exacerbates destabilisation of the shingle ridge, has not been addressed. Furthermore, preventing shingle removal within the footprint of the proposed area for compensatory measures will not be adequate on its own to protect the habitat or preserve the ecosystem functions it provides as a barrier between the open sea and the lagoon."

It is regrettable that the issue above has still not been addressed in the documentation received to date. Firstly, the Compensatory Measures Report does not state the nature of the action that will be undertaken to prevent the removal of sediment, only that such prevention will occur. Secondly, no evidence has yet been provided that this cessation, on its own, will in fact be sufficient to protect the habitat or to preserve the ecosystem functions it provides as a barrier between the open sea and the lagoon. By preventing further extraction, the natural accretion processes acting at the site may result in an increase in the a total area of Perennial vegetation of Stony Banks at Tawin that may, in turn, constitute habitat re-creation due to restoration of the natural processes. Such re-creation could be considered to be compensatory in nature. Unfortunately, there is, as yet, no evidence or information provided by the applicant that allows NPWS to come to a clear view as to whether the proposed measures are adequate. NPWS would be happy to discuss with the applicant the nature of the information and analysis required to facilitate this.

Modification required:

Galway Bay Complex Special Area of Conservation (site code: 000268) will be affected by the direct and permanent loss of fucoid-dominated reef habitat [1140-sic] and mud and sand flat habitat [1140] and the loss of perennial vegetation of stony banks [1220].

[2] See the *Appendix: Statement of Case* to the 24th March letter, in its Reasons for Determination

[3] CMR, 2019 and CMR Appendices 2019.

- **The Applicant is to be requested to provide information/data and analysis to support its case that the cessation of sediment will in itself be sufficient to facilitate habitat re-creation at the site, and to develop any other measures that may be demonstrated to be necessary by that analysis, in order to achieve sufficient compensatory habitat re-creation.**
- **This analysis is to be shared with NPWS for its review, as part of the package of Compensatory Measures.**
- **The applicant's monitoring programme is to be expanded to include the monitoring of the accretion of the shingle bar, and its associated vegetation, in order to determine the success of the measure/s proposed.**
- **The Compensatory Measures Report is to be amended to specify exactly what type of action will be taken to ensure this cessation of extraction.**

The Compensatory Measures Report states that only sensitive repairs will be undertaken on the sea wall due to the potential implications for the lagoon habitat if these sea defences were to fall into disrepair. However, such sea defences are likely to be interacting with the natural processes that sustain the stony bank habitat and vegetation.

Modification required:

- **The CMR is to be amended to include the undertaking of a study of the potential implications for the Annexed habitats of the removal, or maintenance, of the sea defences, with a view to recommending the appropriate course/s of action for achievement of their favourable conservation condition.**

Reef and Mud and Sand Flats:

The objectives of the conservation measures remain vague with respect to marine habitats; these must be further developed to ensure they can be adequately measured and tracked over time. It is also unclear how they can be implemented in an area of foreshore that would not be in the ownership of the proponents, and for which other potential users may come forward in due course. This lack of clarity has been raised previously in correspondence to An Bord Pleanála in August 2019 but it is not clear that this has been communicated to the proponents of the development by the Board.

Modification required:

-The objectives for the conservation measures for these habitats are to be further developed in an iterative manner, in line with their conservation objectives, and associated attributes and targets, in Galway Bay Complex SAC, as the compensatory measures are implemented,.

- The proponents must state in the CMR how they will extend and implement management measures on to the foreshore without a clear and exclusive right to those areas.

The applicant has proposed to undertake a number of conservation actions in the compensatory area that are not directly related to the adverse effects that will arise on the integrity of Galway Bay Complex SAC as a result of this expansion of Galway Port, but that arise from the previous losses incurred by the development of the Galway Harbour Enterprise Park. These measures are to nevertheless to be much welcomed as they should improve the conservation condition of the site, with the following modifications:

Atlantic salt meadows (Glauco-Puccinellietalia maritimae): Grazing during the summer months reduces the wider ecological benefits provided by coastal habitats (specifically relating to bird breeding and pollination) and therefore, does not improve the overall coherence of the Natura 2000 network.

Modification required:

- **Summer grazing is not to occur; it is to be replaced with winter grazing and the monitoring programme amended accordingly.**

Long-term Management of the Site:

It is understood that the applicant will report annually to Galway City Council, as the appropriate planning authority, on the implementation of the Compensatory Measures.

NPWS would also welcome a role in reviewing the reports submitted and in the making of recommendations to the planning authority and the proponent on improvements or modifications that may be made to the management measures, in order to ensure the coherence of the Natura network, and the achievement of conservation objectives.

As allowed for in section 177AB (1) (b), further consultations will be required with An Bord Pleanála and with the applicant and subsequently, a modified proposal re-submitted to you, and henceforth to NPWS for further review. If these required modifications are made, and subject to the clarification regarding compensatory measures for the previous development, I expect to be able to confirm that the measures put forward by the applicant are adequate for the compensation of the Natura network in view of the adverse effects that the Board has concluded will arise to the site integrity as a result of the proposed development.

Yours sincerely,

Andy Bleasdale

Andy Bleasdale,
Principal Officer- Science and Biodiversity
National Parks and Wildlife Service

Appendix B

Minerex Geophysical Survey (November 2021)

Tawin Sea Defences

Oranmore, County Galway

Geophysical Survey

Report Status: Draft

MGX Project Number: 6593

MGX File Ref: 6593d-005.doc

16th November 2021

Confidential Report To:

Galway Harbour Company
Harbour Offices
New Docks
Galway

Tobin Consulting Engineers
Fairgreen House
Fairgreen Road
Galway
H91 AXK8

Report submitted by :
Minerex Geophysics Limited

Unit F4, Maynooth Business Campus
Maynooth, Co. Kildare, W23X7Y5
Ireland
Tel.: 01-6510030
Email: info@mgx.ie

Issued by:

Author: Hartmut Krahn (Senior Geophysicist)

Reviewer: John Connaughton (Geophysicist)

Minerex
Geophysics Limited

Subsurface Geophysical Investigations

EXECUTIVE SUMMARY

1. Minerex Geophysics Ltd. (MGX) carried out a geophysical survey consisting of seismic refraction (p-wave) for the ground investigation for the Tawin Sea Defences at Oranmore, County Galway.
2. The main objectives of the survey were to determine ground conditions under the survey lines and the depth to rock.
3. The geophysical survey established a ground model and the depth to rock under the survey lines.
4. Layers 1 and 2 are beach material and sediments, generally of a very coarse nature.
5. Layer 3 is the top of poor weathered rock that contain tightly packed boulders and infill of beach material within cracks and voids. This layer is interpreted as suitable for supporting sea defences and is resistant to erosion over long time spans.
6. Layer 4 is very good rock that would be extremely resistant to erosion if exposed, and that can bear any sea defences.
7. Generally rock is quite shallow under the survey lines, between elevation of 0 and -2.5mOD. rock can support sea defenses. We interpret that the rock explains the distribution of the peninsular, islands and the offshore bar.
8. The undulating ground elevations on Lurgan Island from south to north are caused by a succession of beach deposits.
9. At line S8 the rock is deeper than on most other liens and this line is close to the northern channel.
10. Line S7 shows a different ground model than the other lines and it was carried out beside a curved erosion features on the north side of Lurgan Island. The interpretation shows an unusual thick layer of beach sediments over thick weathered rock. There could be underlying karstified rock at this location.
11. Possible direct follow-up ground investigation could consist of trial pitting.

CONTENTS

List of Tables, Maps and Figures:

1. INTRODUCTION

1.1 Background

Minerex Geophysics Ltd. (MGX) carried out a geophysical survey for the ground investigation for the Tawin Sea Defences at Oranmore, Co. Galway. The survey consisted of seismic refraction (p-wave) measurements. The survey was commissioned by Tobin Consulting Engineers acting on behalf of Galway Harbour Company.

The sea defenses are on an offshore bar that are protecting a lagoon with ecological valuable and sensitive items. The concrete blocks that protect the offshore bar have been collapsing at the top as the cobbles and pebbles behind them get washed away by large waves. There are also signs of erosion at the northern side of Lurgan Island. The client is considering how to protect the lagoon ecosystem best and requires to know how deep the rock is.

This seismic refraction survey can determine the depth to rock over long profiles rapidly and with minimum impact on the landscape.

1.2 Objectives

The main objectives of the geophysical survey were:

- To determine the ground conditions under the site
- To determine the depth to rock

1.3 Site Description

The lagoon is located at the end of a peninsula and protected by a series of islands located to the north, west and south. There is an offshore bar in the west which is strengthened by sea defences. The sea, tides, waves, surf and wind can erode the islands and offshore bar from the west and north.

The elevations of the land are low and the survey was done between elevations of 0.90 mOD (at low tide) and 4.2 mOD on Lurgan Island.

1.4 Geology

The overburden geology consists of marine beach deposits. The areas facing seawards are covered by sand and shingle, the seaward side of the islands and the offshore bar are made from pebbles, cobbles and boulders and the inside of the lagoon shows some sand at low tide.

The online bedrock geological map of Ireland (GSI, 2021) indicates that the survey area is underlain by the Burren Formation, described as pale grey clean skeletal limestone.

The Burren formation is liable to karstification and karst features are mapped further inland from the site location.

1.5 Report

This report includes the results and interpretation of the geophysical survey. Maps, figures and tables are included to illustrate the results of the survey. More detailed descriptions of geophysical methods and measurements can be found in GSEG (2002), Milsom (1989) and Reynolds (1997).

The description of soil, rock and the use of geotechnical terms (soft, stiff, dense etc) follows Eurocode (2007) and BSI (2015) standards. The terms are defined in the standards and the physical parameters are related from experience. This geophysical survey has been acquired, processed, interpreted and reported in accordance with these guidelines.

The client provided maps of the site and the digital version was used as the background map in this report. Elevations were surveyed on site and are used in the vertical sections.

The interpretative nature and the non-invasive survey methods must be taken into account when considering the results of this survey and Minerex Geophysics Limited, while using appropriate practice to execute, interpret and present the data, give no guarantees in relation to the existing subsurface.

2. GEOPHYSICAL SURVEY

2.1 Methodology

The methodology consisted of using seismic refraction with a 2 m geophone spacing to map the depth to rock.

The survey locations are indicated on Maps 1 and 2. The lines and parameters are tabulated in Table 1.

Table 1: Geophysical Survey Locations and Acquisition Parameters

Seismic Line	Geophone Spacing/m	Number of Geophones	Line Length/m
S1	2	24	46
S2	2	24	46
S3	2	48	94
S4	2	96	190
S5	2	24	46
S6 S7	2 2	48 24	94 46
S8	2	24	46
SUM			**608**

2.2 Seismic Refraction

Seismic refraction lines were surveyed with geophone spacing of 2m and 24 geophones per set-up resulting in a 46m length per set-up. Some set-ups were acquired in longer continuous lines using common shot points between set-ups and concatenating into longer lines at the processing stage (S3, S4, S5).

The recording equipment consisted of a 24 Channel GEOMETRICS ES-3000 engineering seismograph with 4.5Hz vertical geophones. The seismic energy source consisted of a hammer and plate and a seismograph gun in soft ground areas. A zero-delay trigger was used to start the recording. Normally 7 shot points per p-wave set-up were used.

The seismic refraction survey method focuses on propagating p-waves travelling through the subsurface, which are generated by hitting a hammer on a plate or other source. As the wave propagates through the subsurface, its velocity varies as it travels through overburden, rock with different elastic properties, and

along geological boundaries. Velocity data is recorded via the surveying equipment, which is then processed, allowing geological layer thicknesses and boundaries to be established.

Seismic Refraction generally determines the depth to horizontal or near horizontal layers where the compaction or strength or rock quality changes with an accuracy of 10 – 20% of depth to that layer. Where low velocity layers or shadow zones are present (e.g., below solid ground surface) or where layers dip with more than 20 degree angle the accuracy becomes much less.

2.3 Site Work

The data acquisition was carried out on the 9th of November 2021. The weather conditions were fair throughout the acquisition period. Health and safety standards were adhered to at all times. The work was carried out starting after high tide and then the lowest elevated profiles were done around low tide.

The locations and elevations were surveyed with a Carlson NR3 RTK-GPS to accuracy < 0.05m.

3. RESULTS AND INTERPRETATION

The interpretation of geophysical data was executed utilizing the known response of geophysical measurements, typical physical parameters for subsurface features that may underlay the site, and the experience of the authors.

3.1 Seismic Refraction Modelling

The seismic refraction data was positioned and processed with the SEISIMAGER software package to give a layered model of the subsurface. The number of layers has been determined by analysing the seismic traces and 4 layers were used in the models. All seismic lines were subject to a standardised processing sequence which consisted of a topographic correction which was based on integrated elevation data, first break picking, tomographic inversion, travel-time computation via ray-tracing and velocity modelling. Residual deviations of typically 0.4 to 1.2 msec RMS have been obtained for each line. Following each processing stage QC procedures were adhered to. The resulting layer boundaries are shown as thick lines on cross sections (Figure 1). The average seismic velocities obtained within the layers are annotated on the sections as bold black numbers.

The p-wave seismic velocity is closely linked to the density of subsurface materials and to parameters like compaction, stiffness, strength and rock quality. The higher the density of the subsurface materials the higher the seismic velocity. More compacted, stiffer, denser and stronger material will have a higher seismic velocity. For rock, the seismic velocity is higher when the rock is stronger, less weathered and has a higher quality. If the rock is more weathered, broken, fractured, fissured or karstified then the seismic velocity will be reduced compared to that of intact fresh rock.

Because of the above relationship, the seismic refraction method and seismic velocities are suitable to investigate ground where the layers get denser, more compacted and stronger with depth. A disadvantage is that some materials may have the same seismic velocity.

3.2 Seismic Refraction Interpretation

The modelled seismic data has created the following interpreted layered ground model:

Layer 1 has a thickness of 0.4 - 3.5m and seismic velocities of 250 – 350m/s. This overburden is interpreted as loose beach material and consists mainly of pebbles, cobbles and boulders. Where is layer was less exposed to waves and surf in the past there are higher amounts of sand and gravel in the material. This layer was not water saturated at the time of the survey.

Layer 2 was modelled with an average velocity range of 1500m/s and has a thickness of 0.7 to 6m. The composition is dense and these beach sediments contain similar grain sizes that Layer 1. This layer is also mainly water saturated.

Layer 3 velocities of 2800m/s are indicating poor weathered rock. The rock type is limestone. This weathered rock can contain fractured, fissured or karstified limestone. This layer can also contain tightly packed boulders and beach material that has infilled cracks and voids in the rock. The elevation of the top of this layer is between 0.5 and -5mOD.

Layer 4 velocities of 4800m/s indicate very good limestone rock. The top of this layer occurs between -1.5 and -7mOD. On line S7 this layer was not encountered to a depth of -10mOD (the meaningful penetration depth).

Table 2 summarises the interpretation. The stiffness or compaction and the rock strength or quality have been estimated from the seismic velocity. Interpreted cross sections are shown in Figure 2.

Table 2: Summary of Interpretation

Layer	**General Seismic Velocity Range (m/sec)**	**Stiffness or Compaction or Rock Quality**	**Interpretation**
1	250 - 350	Loose	Beach Material
2	1500	Dense	Beach Sediment
3	2800	Poor rock	Weathered Limestone with some Boulders and Infill Material
4	4800	Very good rock	Limestone

4. CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations are made:

- The geophysical survey determined the depth to rock under the survey lines.
- The top of rock is the top of the weathered rock in Layer 3 in this interpretation. The rock is of poor quality, and can contain tightly packed boulders and infill of beach material within cracks and voids in the rock. We consider this layer as capable of bearing sea defences. Erosion of this layer, where exposed, would only take part over very long times. Despite the weathered nature of this rock we consider the bearing capacity for sea defences sufficient.
- Layer 4 is very good rock that would be extremely resistant to erosion if exposed, and that can bear any sea defences.
- Layers 1 and 2 are beach material and sediments, generally of a very coarse nature. These layers can be eroded and moved over time by the action of the sea. They are the base for the current sea defences on the offshore bar.
- Line S4 runs along the landward side of the offshore bar. The top of rock (Layer 3) occurs here quite shallow, between 0 and -2.5mOD. The very good rock is not too deep below that, generally 2 to 4 m below this level. At the southern end, where a little original island was noted under the offshore bar, the rock seems to be locally a little shallower. This could explain the presence of the little island.
- Line S5 is located where the land stretches out further at low tide and the rock is also quite shallow, though with a few more undulations than at Line S4.
- Line 6 runs south to north across Lurgan Island and it shows that the undulating ground elevations are caused by a succession of beach deposits. There was a possibility that there could be rock outcrop here but the survey shows that the ground undulations are cause by phases of beach material deposition.
- Line S7 is done beside a curved erosion features where the sea has advanced into the north side of Lurgan Island. The interpretation shows an unusual thick layer of beach sediments over thick weathered rock. Very good rock is not found in the modelling to a level of -10mOD. It is concluded that in the past the weathered rock has been eroded deeper than in other places and that the ground was filled up with beach sediment to larger thickness. The sea is now eroding the thicker beach sediments. Underlying could be karstified rock.
- Line S8 is close to the lagoon and the channel in the north. The top of rock is deeper here than on other lines, generally below -2.5mOD. This is the likely reason that the island is thinner here and that the channel is present.

- Line S1 is on the other side of the channel and the top of rock is shallower here with elevation 0 - 2mOD. The shallower rock here, compared to S8, can explain that this tip of the peninsular has not been eroded.
- Lines S2 and S3 show relatively flat and shallow rock at elevations between 0 and -2.5 mOD.
- Possible direct follow-up ground investigation could consist of trial pitting. The area is accessible for a tracked or wheeled excavator. Methods like drilling or dynamic probing seem futile in this geological setting with a large amount of pebbles, cobbles and boulders.

5. REFERENCES

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2. **Eurocode, 2007:** EN 1997-2:2007. Eurocode 7. Part 2 Ground Investigation and Testing 2007

3. **GSEG, 2002.** Geophysics in Engineering Investigations. Geological Society Engineering Geology Special Publication 19, London, 2002

4. **GSI, 2021.** Online Bedrock Geological Map of Ireland. Geological Survey of Ireland 2021

5. **Milsom, 1989.** Field Geophysics. John Wiley and Sons, 1989

6. **Reynolds, 1997.** An Introduction to Applied and Environmental Geophysics. John Wiley and Son, 1997

N

Sand & Shingle

HWM

Erosion Feature

S7

S8

Lurgan Island

S6

Channel (dry at low tide)

S1

Sand & Shingle

Sand & Shingle

Creggauns

S5

Boulders

HWM

HWM

HWM

Peninsula

S2

S3

HWM

Mud

Offshore Bar

Interlocking Concrete Blocks

S4

Lagoon

Small Island

Boulders

Channel (draining at low tide)

Mud

Sand & Shingle

Minerex
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Web: www.mgx.ie

CLIENT	Galway Harbour Company Tobin Consulting Engineers
PROJECT	Tawin Sea Defences, Oranmore Geophysical Survey
TITLE	Map 1: Geophysical Survey Location Map

SCALE:	1:2500 @ A3
PROJECT:	6593
DRAWN:	HK
DATE:	03/11/2021
MGX FILE:	6593d_Drawings.dwg
STATUS:	Draft

Geophysical Survey Locations:

S1 Seismic Refraction Line

Locations are In Irish Transverse Mercator (ITM), Elevations are In mOD (Malin Head)

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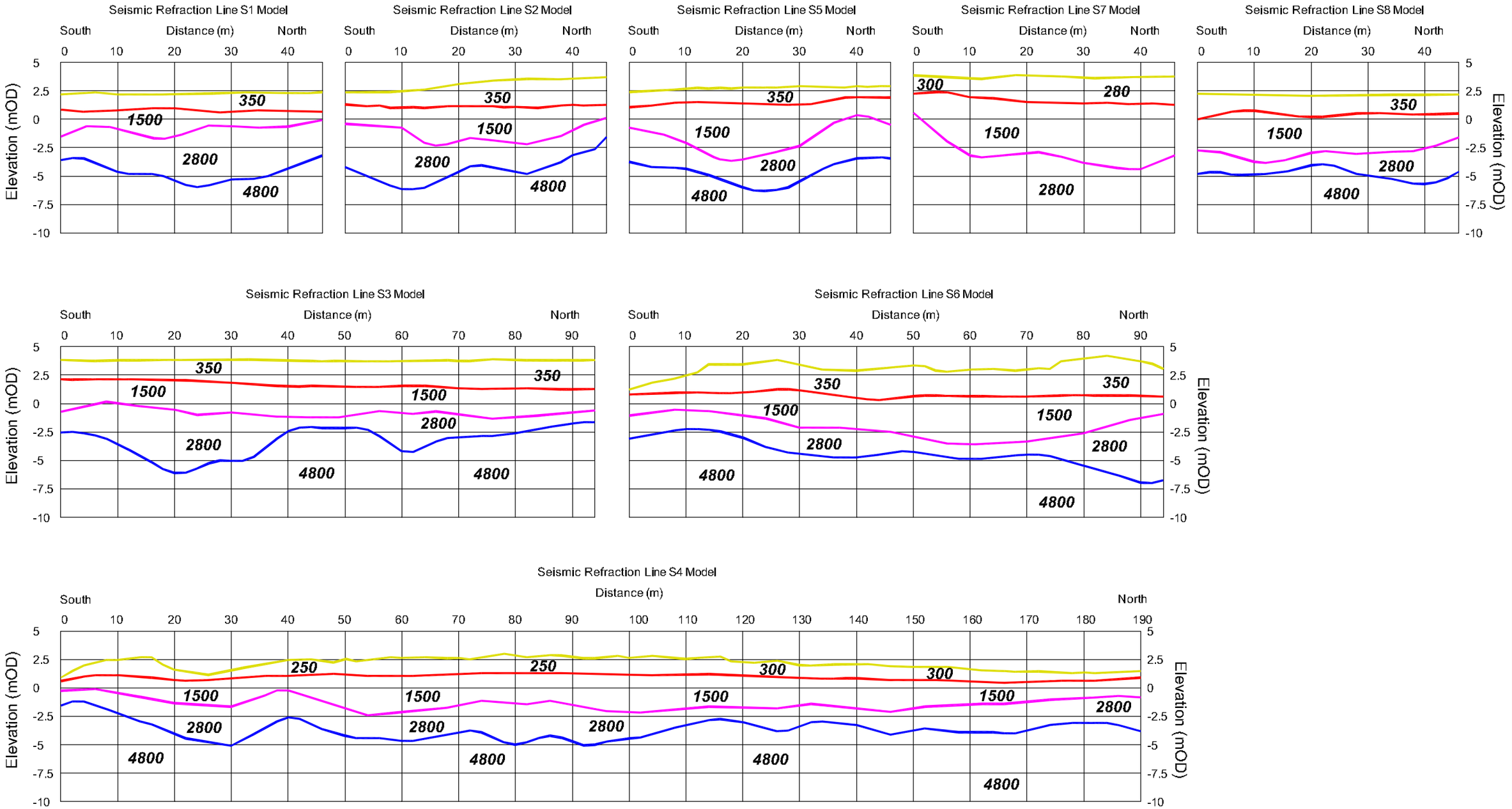
CLIENT	Galway Harbour Company Tobin Consulting Engineers
PROJECT	Tawin Sea Defences, Oranmore Geophysical Survey
TITLE	Map 2: Geophysical Survey Location Map on Aerial Image

SCALE:	1:2500 @ A3
PROJECT:	6593
DRAWN:	HK
DATE:	03/11/2021
MGX FILE:	6593d_Drawings.dwg
STATUS:	Draft

Geophysical Survey Locations:

S1 Seismic Refraction Line

Locations are In Irish Transverse Mercator (ITM), Elevations are In mOD (Malin Head)



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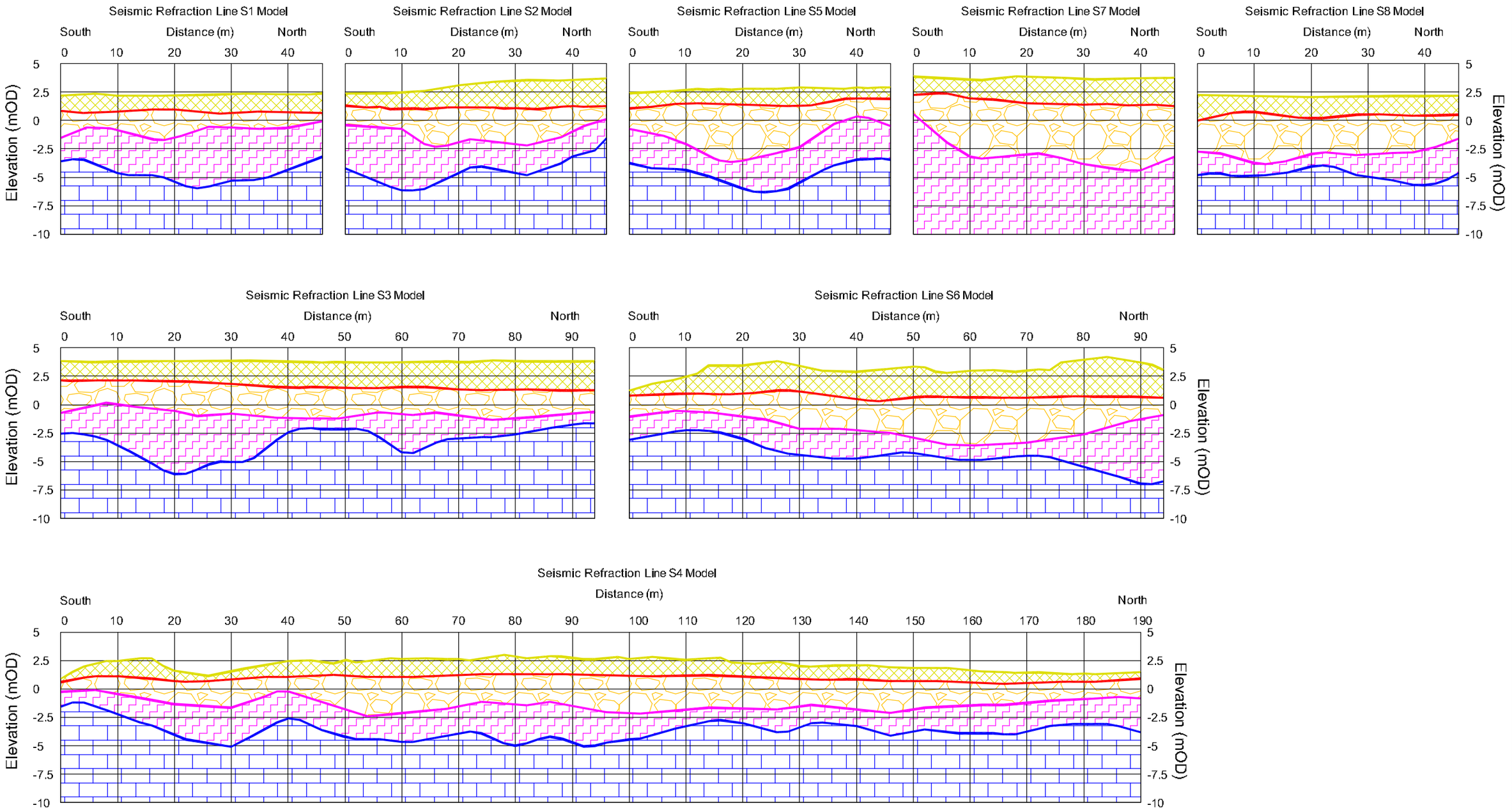
CLIENT	Galway Harbour Company Tobin Consulting Engineers
PROJECT	Tawin Sea Defences, Oranmore Geophysical Survey
TITLE	Figure 1: Models of Geophysical Survey

SCALE:	1:2500 @ A3
PROJECT:	6593
DRAWN:	HK
DATE:	11/11/2021
MGX FILE:	6593d_Drawings.dwg
STATUS:	Draft

Layers from Seismic Refraction Model:

- Ground Surface/Top of Layer 1 (200 - 350 m/s)
- Top of Layer 2 (1500 m/s)
- Top of Layer 3 (2800 m/s)
- Top of Layer 4 (4800 m/s)

1800 Average Seismic Velocity in m/s



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CLIENT	Galway Harbour Company Tobin Consulting Engineers
PROJECT	Tawin Sea Defences, Oranmore Geophysical Survey
TITLE	Figure 2: Interpretation of Geophysical Survey

SCALE:	1:2500 @ A3
PROJECT:	6593
DRAWN:	HK
DATE:	11/11/2021
MGX FILE:	6593d_Drawings.dwg
STATUS:	Draft

Interpretation:

1 Loose Beach Material
2 Dense Beach Sediment
3 Poor weathered Limestone with some Boulders and Infill Material
4 Very good Limestone

Appendix C

Shoreline Topographical Survey (November 2021 and February 2022)

THE INFORMATION ON THIS DRAWING IS TO THE ORDNANCE SURVEY IRELAND ITM COORDINATE SYSTEM

Sea Defences
Rock Armour

Sea Defences
Concrete Armour

Sea Defences
Rock Armour

Sand & Shingle

Creggauns

Ballaghbristy

Mud

Goose Island

HWM

GALWAY	Chart Datum (m)	OD Poolbeg (m)	OD Malin Head (m)
MHWS	5.10	4.90	2.19
MHWN	3.90	3.70	0.99
MLWN	2.00	1.80	-0.91
MLWS	0.60	0.40	-2.31
HAT	5.74	5.54	2.83
LAT	-0.16	-0.36	-3.07
Mean Sea Level	2.60	2.40	-0.31
Mean Range Springs	4.50	4.30	1.59
Mean Range Neaps	1.90	1.70	-1.01

LEGEND

- SALT MARSH UPPER CONTOUR SURVEY SEPTEMBER 2017
- SALT MARSH LOWER CONTOUR SURVEY NOVEMBER 2021
- OSI BACKGROUND MAP PURCHASE MARCH 2019
- TRANSECTS SURVEY 2017
- TRANSECTS SURVEY NOVEMBER 2021
- EROSION OR ACCRETION IN METERS
- COASTAL ARMOUR BOTTOM
- COASTAL ARMOUR TOP
- EXISTING LEVEL
- EXISTING LEVEL ESTIMATED

NOTES:

1. FIGURED DIMENSIONS ONLY TO BE TAKEN FROM THIS DRAWING.
2. ALL DRAWINGS TO BE CHECKED BY THE CONTRACTOR ON SITE.
3. ENGINEER/EMPLOYERS REPRESENTATIVE, AS APPROPRIATE, TO BE INFORMED BY THE CONTRACTOR OF ANY DISCREPANCIES BEFORE ANY WORK COMMENCES.
4. THE CONTRACTOR SHALL UNDERTAKE A THOROUGH CHECK FOR THE ACTUAL LOCATION OF ALL SERVICES/UTILITIES, ABOVE AND BELOW GROUND, BEFORE ANY WORK COMMENCES.
5. ALL LEVELS SHOWN RELATE TO ORDNANCE SURVEY DATUM AT MALIN HEAD.

D04	01.12.2021	Minor Revsion	JK	BR
D03	25.11.2021	Additional survey data	JK	BR
D02	15.11.2021	Minor Revision	JK	BR
D01	09.11.2021	First Issue	JK	BR

Client: GHC

Project: Tawin

Title: Transects Comparison 2017 / 2021

Prepared by: JK

Checked: BR

Date: November 2021

Project Director: Michael McDonnell

Drawing Status: Information

Scale @ A1: 1:2000

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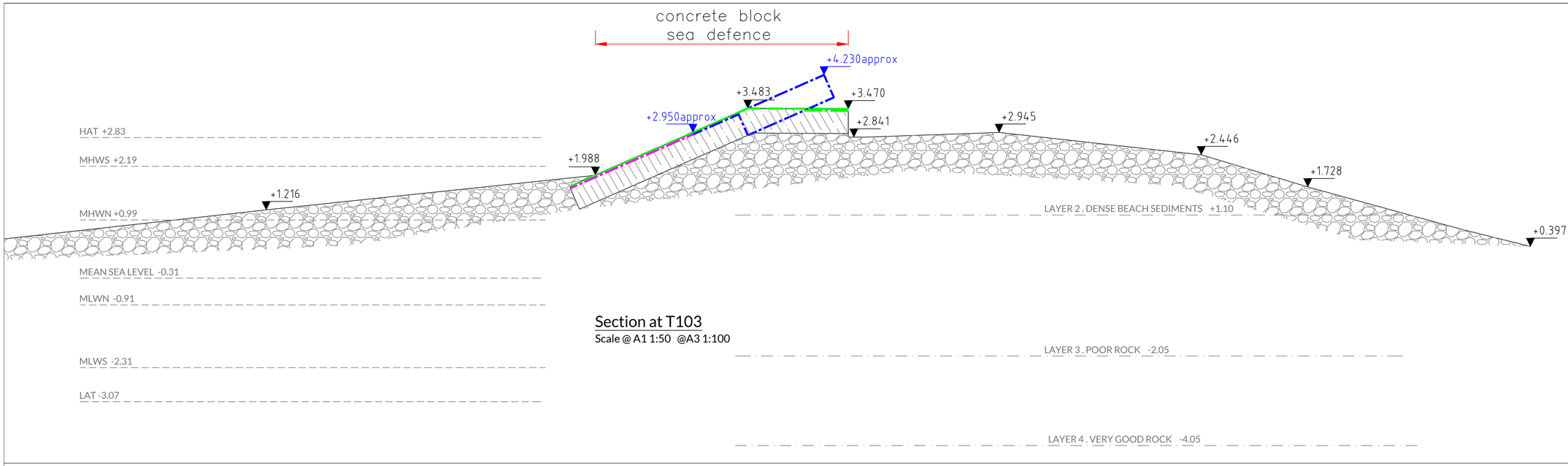
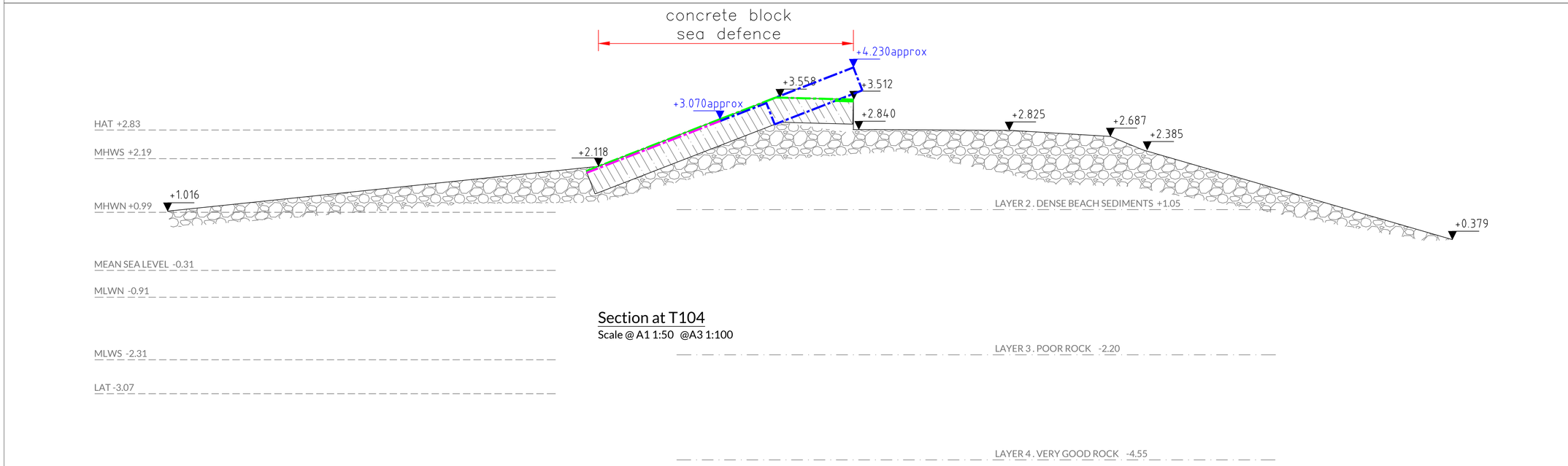
Drawing No.: 7476-SK201

Revision: D04



Section at T103

Scale @ A1 1:50 @A3 1:100



Section at T104

Scale @ A1 1:50 @A3 1:100

1. Photo at construction

2. Photo at construction

3. Photo January 2021

4. Photo November 2021

THE INFORMATION ON THIS DRAWING IS TO THE ORDNANCE SURVEY IRELAND ITM COORDINATE SYSTEM

LEGEND:

- ESTIMATED ORIGINAL SEA DEFENCE
- ESTIMATED ORIGINAL SEA DEFENCE BELOW BEACH LINE
- EXISTING SEA DEFENCE

GALWAY	Chart Datum (m)	OD Poolbeg (m)	OD Malin Head (m)
MHWS	5.10	4.90	2.19
MHWN	3.90	3.70	0.99
MLWN	2.00	1.80	-0.91
MLWS	0.60	0.40	-2.31
HAT	5.74	5.54	2.83
LAT	-0.16	-0.36	-3.07
Mean Sea Level	2.60	2.40	-0.31
Mean Range Springs	4.50	4.30	1.59
Mean Range Neaps	1.90	1.70	-1.01

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5. ALL LEVELS SHOWN RELATE TO ORDNANCE SURVEY DATUM AT MALIN HEAD.

Rev	Date	Description	By	Chkd.
D04	05.01.20222	Minor Revision	JK	BR
D03	25.11.2021	Geophysical Data	JK	BR
D02	17.11.2021	Minor Revision	JK	BR
D01	15.11.2021	First Issue	JK	BR

Client: GHC

Project: Tawin

Title: Concrete Armour Section at T103 and T104

Scale @ A1: 1:50

Prepared by: JK | Checked: BR | Date: Nov 2021

Project Director: Brian Carroll

Drawing Status: Preliminary

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Revision:

Drawing No.: 7476-SK205 D04

Appendix D

Blake and Kenny Solicitors Confirmation

Re: New Land Purchase Agreement (Tawin West)

BLAKE & KENNY
SOLICITORS

Blake & Kenny LLP, Solicitors
2 St Francis Street, Galway H91 CA37
Tel: (091) 564 340
Fax: (091) 564 915
Email: info@blakeandkenny.ie
DX: 4518 Galway Mary Street

The Directors
Galway Harbour Company
Harbour Office
New Docks
Galway

Our Ref: EM/CM10138M 7th October 2022
(please quote our reference on all correspondence)

RE: Galway Harbour Extension
Planning Reference 60.PA.0033
Compensatory Lands Folios Part of GY49496F (Plan 15B) and GY66724F (Plan 15B); GY12470

Dear Sirs,

We confirm that we act on behalf of the Galway Harbour Company (hereinafter referred to as GHC) and write to confirm that GHC has entered into an Agreement on the 7th October 2022, with a 6 year option from the 7th of October 2022. The Option Agreement provides that if and when a satisfactory Grant of Planning Permission is obtained, GHC can call upon the registered owners to complete a sale of the land delineated in red on the map attached hereto and comprised in plan 15B in the following Folios: -

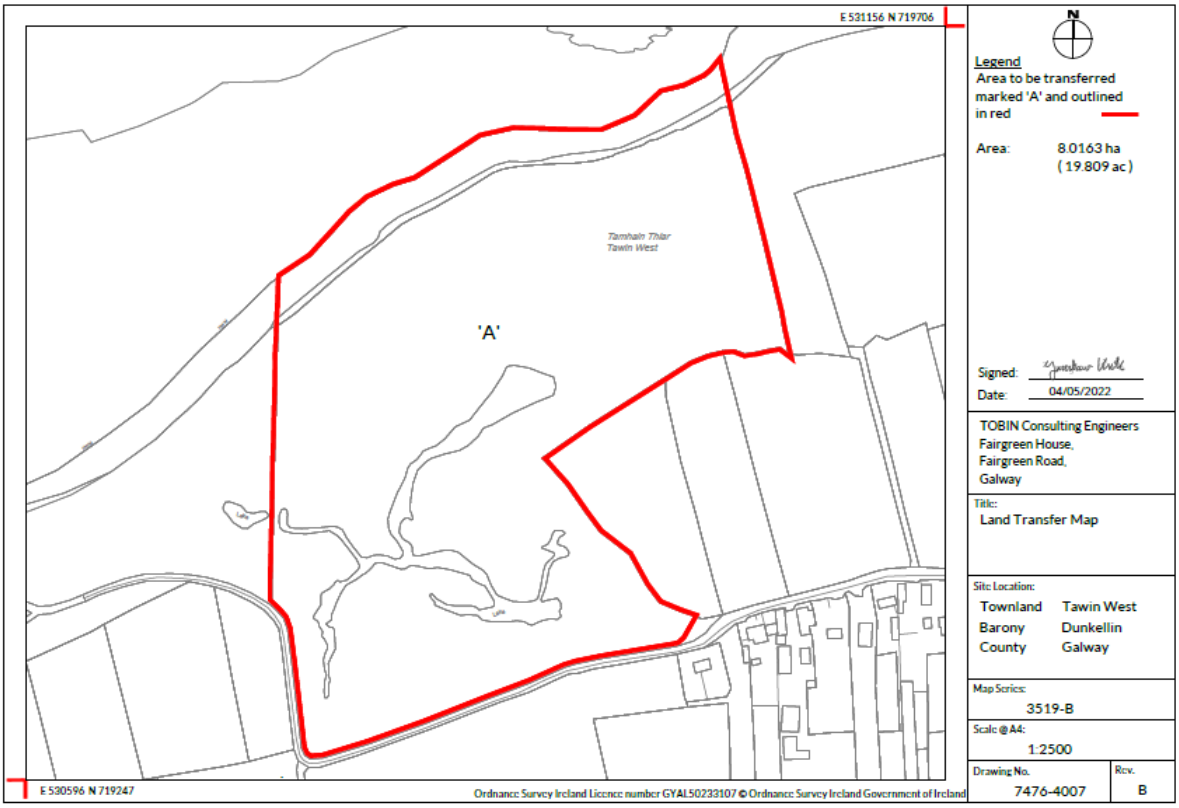
A. Folio GY65724F – being 3 undivided 8th parts,
B. Folio GY449496F – being 3 undivided 8th parts,
C. Folio GY12470 – being one undivided 4th part.

Yours faithfully,

BLAKE & KENNY LLP

BLAKE & KENNY LLP

Enc.


E 531156 N 719706
Tamhain Thiar
Tawin West
'A'
E 530596 N 719247
Ordnance Survey Ireland Licence number GYAL50233107 © Ordnance Survey Ireland Government of Ireland
N
Legend
Area to be transferred marked 'A' and outlined in red
Area: 8.0163 ha (19.809 ac)
Signed:
Date: 04/05/2022
TOBIN Consulting Engineers
Fairgreen House,
Fairgreen Road,
Galway
Title:
Land Transfer Map
Site Location:
Townland Tawin West
Barony Dunkellin
County Galway
Map Series:
3519-B
Scale @ A4:
1:2500
Drawing No.
7476-4007
Rev.
B

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