Marine Planning Matters Environment Consulting Ltd

Review Comments on: Galway Harbour extension (Strategic Infrastructure Case 61.PA0033): Compensatory Measures Report 2019: Reply to further information

For An Bord Pleanála –Project P-ABP-004
February 2020

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Project number	Report number	Issue number	Issue date
P-ABP-004	001	001	04/02/2020
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Executive Summary

This is a report of my review comments on the response provided by the Galway Harbour Company to a series of 10 questions raised by An Bord Pleanála (The Board) in relation to their report on the proposed compensatory measures to offset the adverse impacts of the development on Galway Bay Complex SAC.

My response is structured following the ten questions and replies, with the objective of addressing the following points:

- Have the answers fully addressed the issues in question and provided a full response?
- Are there outstanding issues which require further clarification or modification?

In general, the issues raised by the Board in their questions have been addressed by the responses provided by the applicant. These responses clarify the doubts and concerns raised, and provide further information on the proposed monitoring programme to validate the predictions made in relation to the outcomes of the compensatory measures.

Importantly, all elements of the monitoring programme now have clear objectives and appropriate targets and indicators. The methodologies proposed for the monitoring programmes for most of its components – stony shingle banks, salt marsh and intertidal habitats - are fit for purpose. However, whilst the methodology proposed for monitoring intertidal benthic communities represents a significant improvement in relation to their initial proposal, it still requires further modifications. These involve the use of replicate benthos samples to provide enough data for enabling robust and meaningful statistical analysis, and ensuring that samples are taken at the same period of the year in which the baseline samples were taken.

1. Introduction

Following the submission of the Compensatory Measures Report (Ref: 61.PA 0033, April 2019) by the Galway Harbour Company (GHC), and my own report (Ref P-ABP-003, September 2019) on the proposed compensatory measures to address the environmental impacts of the construction of the new harbour on the Galway Bay Complex SAC, the Board requested the applicant clarification on 10 points related to their report of April 2019. These points relate mainly to the proposed monitoring programme, its objectives and methodology, and to a lesser extent, to lack of clarity on other specific issues.

The 10 questions were addressed by GHC in a report (Galway Harbour Extension: Compensation - Reply to Further Information, – Tobin Consulting Engineers & Aquafact, December 2019). Their response includes further information on the objectives of the monitoring programme, rationale beyond the selection of the marine reference site location and methodology

2. The Brief

The Board has requested a report with my review comments of this report and the responses submitted by the applicant.

My response is structured following the ten questions and replies, with the objective of addressing the following points:

- Have the answers fully addressed the issues in question and provided a full response?
- Are there outstanding issues which require further clarification or modification?

3. Discussion

3.1 Question 1:

There are specific concerns that the monitoring programme to be employed may not provide an effective method to measure the success of the compensatory measures. Detailed monitoring is required to test the success of the compensatory measures. It is considered that there are ***no clear specific objectives for the monitoring programme*** *which set out measurable outcomes on which the success or otherwise of the proposed compensatory measures can be ascertained. The compensatory measures need to be* ***compared against a set of established indicators and thresholds****. Please provide an* ***appropriate methodology*** *to address this issue.*

The focus of this question is on the objectives of the monitoring programme, and the lack of indicators and methodology to establish the success – or not – of the proposed compensatory measures.

The applicant's response to this question is focused on further explanation of the compensatory measures, and on the methodology for establishing indicators for measuring success.

Indicators have been provided for the proposed compensatory measures, though some confusion remains between the objectives of the compensatory measures and those of the monitoring programme. Overall, the objectives of the monitoring programme – which are those that question 1 refers to – are indirectly addressed in the reply. The response to this question is divided in relation to the three different compensation measures:

Intertidal areas: control of *Didemnum sp.*

For the control of the alien invasive tunicate *Didemnum sp.*, the proposed threshold is a statistically significant reduction of abundance (or density, as referred to in the response) after a period of five years after removal. This is a clear objective, feasible and appropriate to measure the success of this specific compensatory measure.

However, the objective of the monitoring programme is not stated in the response. This should be: **To provide quantitative data to enable a comparison of abundance (or density, which is a measurement of abundance over a specific area) of *Didemnum sp.* before and after the implementation of the compensatory measures**. This is, to verify the prediction that the proposed measures will lead to a reduction of the abundance of this invasive alien species. Or in scientific terms, to test the hypothesis. Whilst this is not specifically included in the submission, it is implicit in the response, and I am satisfied that this addressed this specific question in relation to monitoring the eradication of *Didemnum sp.*

Intertidal areas: stopping oyster aquaculture

The removal of oyster trestles and cessation of tractor traffic is expected to improve the ecological status of the benthic community at the site. The objective of the monitoring programme in relation to the evaluation of the benthic communities at the site is stated in Appendix 3: "*the temporal changes at the fallowed sites will be compared to temporal changes at a nearby trestle oyster site where cultivation activity will be continue 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*".

In the main text of the response, it is stated that univariate and multivariate statistical analyses will be used to compare changes in the chemical properties of the sediment and the infaunal benthic communities, allowing for comparisons on the before and after conditions ("ante et post", as it is referred to in the report) in the 'fallowing' of the site – this is, the cessation of aquaculture. By comparing specific community data and indices in the compensatory site and a nearby site where oyster aquaculture will continue, and before and after parameters in the compensatory site, it will be possible to detect changes in the benthic community at the compensatory sites. This approach is methodologically correct.

Whilst the objectives of the monitoring programme have not been specifically stated in the response, they can be inferred from the proposed methodology: **to provide data to enable comparison of the before and after scenario, and the compensatory**

site with a nearby site where oyster aquaculture will continue. This is to verify that the intertidal benthic communities at the aquaculture site will experience a positive impact once aquaculture stops.

Intertidal areas: changes to farming practice

The success of these specific compensatory measures will also be measured in relation to changes in the infaunal benthic populations community parameters. For this, my comments above also apply.

Stony bank habitats

The objective of the monitoring programme for these habitats is defined in the response – compare the results of vegetation data in the area subject to controlled grazing with that of the area that will not be subject to control.

Four management objectives are also detailed in the response: increasing species richness, flowering and seeding, establishing a varied sward height and monitoring the distribution and cover of the nationally rare yellow horned poppy.

Saltmarsh habitat

The objective of the monitoring programme is stated in the response. This is to compare plant species richness, degree of flowering and height of vegetation in both the compensatory area and the area that will not be subject to controlled grazing.
The survey methodology for the acquisition of these data (use of quadrats) is explained in the response.

Response to Question 1: Summary

The points raised in question 1 have been addressed in the applicant's response. An important element of the Board's concern in relation to the methodology of the monitoring programme was related to the use of a reference site to compare the benthic community's abundance and diversity parameters in the compensatory areas

and a reference area, as suggested in my previous report. This was addressed by the applicant, and their proposed methodology explained in their communication of 10th December 2019 (email from John P. Kelly to the Board) and their report of December 2019.

The applicant has taken on board the suggestion of using a reference area to monitor benthic communities in the intertidal areas where the compensatory measures will be implemented. This is an appropriate approach to enable comparison between the 'before and after' scenario. Some concerns remain in relation to the details of the proposed sampling strategy, and these are discussed in my response to the reply to question 10.

Whilst some degree of confusion remains in relation to which are the objectives of the monitoring programme for intertidal habitats and which are the objectives of the compensatory measures for these habitats, the response itself suggest that the former are now clear. There are no outstanding issues in relation to this question.

3.2 Question 2:

The applicant is requested to demonstrate that the disturbance of the perennial stony bank vegetation [1220] at Renmore is only attributed to tidal disturbances, and that no disturbance can be attributed to trampling or shingle extraction. The Board consider that disturbances to the Stony Bank could be attributed to trampling due to anthropogenic interference with recreational walker and dog walkers etc.

The response to this request from the Board is based on the undisputed fact that natural events have a significant impact on the structure and vegetation coverage of the shingle bank at Renmore. It is a well-known fact that natural events such as major storms have more significant adverse impacts on coastal habitats and their biological communities than most human activities. However, this is not the point in discussion. It is the claim that the action of tides and storms are the **only** form of disturbance. Clearly this is not the case, as it is demonstrated by the observations made in December 2019 by the applicant's consultants. According to the response, walkers were observed on the stony bank habitat. While the reported numbers are relatively

low, according to their own figures, seven people (up to 37% of up to 19 people) walked over the shingle bank on a daily basis in December. This figure will surely increase significantly in the spring and summer, when possibly dozens of people will walk on the shingle on a daily basis. While there is no evidence to support any impact assessment of these activities, it is apparent that trampling is a regular form of disturbance. As a result of this, the claim that the only form of disturbance to the site is due to the action of natural events is unsubstantiated. I refer to my previous report (Section 3.1.1). Furthermore, if more sheltered conditions will occur as a result of the expansion of the harbour under the current application, the impact of trampling will become relatively more significant, as natural disturbance would diminish.

Response to question 2: Summary

I consider that this issue has been sufficiently discussed, and there are no standing issues.

3.3 Question 3:

The applicant is requested to comment on the hypothesis that the expansion of the harbour under the current application will lead to increased shelter conditions which may in turn, improve the condition of the perennial vegetation of stony banks at Renmore

I consider that this request has been addressed in the applicant's response. On the basis of the information provided, they conclude that there is uncertainty about whether the more sheltered conditions will lead to a more grassy shingle habitat or the periodic storm disturbance caused by storms blowing from a SSE direction will in fact maintain the naturally dynamic nature of this habitat, which would be reflected in the plant community at the site. I concur with this view.

Response to Question 3: Summary

The response to this question addresses the points made in the question, and there are no outstanding issues.

3.4 Question 4:

The results of the intertidal survey at Renmore are presented in appendix 4 of the main report. It states that the surveys were undertaken between the 28th and 29th October 2015. The previous version of this Appendix issued in February 2016 states that the surveys were carried out in January 2016. Please clarify the survey dates.

Response to question 4: Summary

The survey dates were clarified in the response. The samples were taken in October 2015. There are no other outstanding issues in relation to this.

3.5 Question 5:

Please provide data of sediment chemistry to support the conclusion that the difference between groups A, B and C of infaunal macrobenthos identified in Renmore using cluster analysis techniques are due to high organic loads. Please discuss this in more detail, taking into consideration other natural and anthropogenic variables that may also explain these differences, and the evidence available to support any hypotheses on the distribution of infaunal benthic species and abundance in Renmore. Further data is required to support the conclusions reached.

The applicant has not provided sediment chemistry data, nor sufficient evidence to support this conclusion. The table provided in the response is only for the percentile of organic carbon lost after ignition, which ranges between 1.15 % to 8.16 %. They once more attempt to explain the distribution of the benthic communities at the site in relation to organic carbon in the sediment, but since data on other determinands are not available, it is not possible to determine if organic carbon is indeed the cause of the observed distribution, as correlation with other variables cannot be calculated. As a result, the response to this question is an iteration of the rationale presented in the previous report, and does not provide conclusive support to the hypothesis that the

composition of the benthic infaunal community at the site is controlled by the contents of organic carbon in the sediment.

While it is a fact that there is usually a correlation between the contents of organic carbon in intertidal sediment and composition of the infaunal communities, there are also correlations between benthic infauna and other variables. These include grain size, silt content, physical disturbance, salinity, exposure to waves and wind, predation, relationship between the content of carbon and nitrogen in the sediment and sediment contamination due to several possible sources. There are not sufficient data to test this hypothesis, due to the lack of data on other variables, and also, due to the limited amount of benthic and sediment carbon data.

In relation to the results of the cluster analysis, this does not identify three distinctive groups, but two. These are the group labelled as 'a', which includes samples from stations 5, 8,9 and 10, and another group including stations 1, 2, 3, 4, 6 and 7 (corresponding to the groups labelled as 'b' and 'c' in the report). This second group is divided in two subgroups, one including stations 1 and 2, and another group including stations 3,4,6 and 7. Cluster analyses is one of the standard multivariate method used to explain similarity in species and abundance in samples in large datasets. In this case, the percentile of similarity (as shown in the 'y' vertical axis in the plot) between the two main groups is 30%. The plot shows that similarity between the four stations first group (stations 5, 8, 9 & 10) is approximately 50%, whilst the similarity between stations 1,2,3,4,6 & 7 is approximately 45%. Higher levels of similarity are observed for stations 1 & 2; 5 & 9, and 6 & 7.

The only other variable which is available to compare with the results of the cluster plot is particle size. This shows that samples from sites 1 & 2, 5 & 9 and 6 & 7 have similar composition in relation to grain size, when compared with the samples from the other sites, as it is shown in table 2 and figure 2 in the report. These sites are precisely those in which the cluster plot of faunal analyses also shows highest similarity, and in consequence, it could also be argued that it is particle size distribution that explains the distribution of species composition and relative abundance in the intertidal benthic macrofauna. Particle size is the most frequent factor controlling distribution of

macrofaunal benthic communities, though as it was mentioned above, not the only one.

Furthermore, the raw data (in Appendix 4 of the July 2019 Report) shows that the total amount of species and individuals found in samples taken at sites 9 & 10 are four species and 43 individuals: 39 polychaete worms, 2 brown shrimps and 9 shellfish. Clearly this is not a sufficient amount of data to draw valid quantitative conclusions. Additionally, the four species of polychaete worms found in sites 9 & 10 (*Eteone longa*, *Nephtys hombergii*, *Pygospio elegans* and *Capitella sp.*) are all opportunistic species and tolerant of organically enriched and polluted sediment. Looking at the raw data for samples from stations 1&2, these are strongly dominated by the *Tubificid sp.* oligochaete worms, and that is the reason why these two stations have been linked at a high level of similarity in the cluster analysis.

Overall, and not surprisingly considering the small size of the dataset, the results are not conclusive. It is possible indeed that the content of organic carbon in the sediment may be the main factor explaining distribution and abundance of species in the area, or perhaps it is instead the particle size of sediment. However, the main point is that the amount of data, both in terms of number of samples and spatial coverage, and the lack of data on other sediment chemistry variables are not enough to test this or any other hypothesis. If this was important – which it is not, as it is not relevant to the evaluation of the success or not of the compensatory measures – a robust sample design would be necessary. This should involve the use of statistical power methods to calculate the necessary number of samples, and it would require a much larger spatial scale. It would require further data on other sediment chemistry determinands to enable meaningful numerical multivariate analyses, such as cluster and Multidimensional Scaling (MDS), and the use of correlation studies involving both biological and non-biological data. Additionally, the spatial coverage of the survey is not sufficient to test the hypothesis presented – this would require sampling a larger area, and the use of replicate samples to avoid errors due to the patchy distribution of contaminants in sediment. This is well outside of the scope of the monitoring programme, and for this reason, it is not necessary to consider such studies. These issues were also discussed in my previous report to the Board (September 2019), and the comments made in it remain valid.

Response to Question 5: Summary

For the above reasons, the conclusion that the available data on organic carbon is sufficient to explain the distribution of the macrofaunal communities in Renmore is not supported by evidence. However, this is not relevant to the monitoring programme for intertidal communities, so not an outstanding issue to be resolved.

3.6 Question 6:

Please provide full results of particle size analysis which were undertaken as part of the survey but are not presented in the report.
This has been addressed in the applicant's response, and I have discussed the results in my response to the previous reply. There are no outstanding issues in relation to this question.

3.7 Question 7:

The report also claims that during the many decades in which untreated raw sewage discharged into the River Corrib and / or via a pipe to the south of Nimmo's Pier that this has given rise to sediment with low levels of oxygen, high levels of sedimentary hydrogen sulphide and therefore reduced numbers of infaunal invertebrates. However, the survey results indicate the opposite. Sites closer to the River Corrib have the highest number of infaunal invertebrates. Please comment further on this, especially in relation to any available data on hydrogen sulphide, and the influence of other variables that may determine distribution of infaunal macrobenthos, particularly particle size of sediment.

The applicant's response acknowledges that in fact those sites closer to the River Corrib have the highest number of individuals, as is shown in their own data. This closes the issue in relation to the first part of the question.

In relation to the second, they state that the higher numbers of macrobenthic invertebrates in these sites respond to the high values of abundance of opportunistic,

stress-tolerant species, such as oligochaete worms of the Genus *Tubificoides* and polychaete worms of the Genus *Capitella*, which is correct.

However, if we look at the data of the samples in the opposite end, those that are the farthest from the Corrib River's mouth (stations 9 & 10), which are considered in the report as being the least affected by organic enrichment, and having the lowest content of organic carbon, the only four polychaete species represented in these samples (*Eteone longa*, *Nephtys hombergii*, *Pygospio elegans* and *Capitella sp.*) are also tolerant of organically enriched and polluted sediment. Whilst it is true that oligochaete of the Genus *Tubificoides* are indicators of organically rich sediment, the fact is that – like most estuaries or bays which are surrounded by agricultural land and with high density of human population – the totality of Galway Bay is subject to organic enrichment. The sources of nutrients leading to organic enrichment in European waters are both point sources, such as discharges from sewage treatment works, and diffuse inputs, due to farming. Often the second is the larger source of nutrients, as improvement on water quality in the effluents – driven mainly by the EU Water Framework Directive has reduced the relative contribution of nutrients from point sources.

The distribution of benthic communities was discussed in my comments to the response to question 5.

It is also stated in the response that the organic matter in the sediment is inert. This is a mistake: organic matter in the sediment reacts with oxygen and other elements, and can be transformed or degraded by biological activity.

Response to question 7: Summary

Overall, the applicant's response acknowledges that the sampling sites closest to the mouth of the River Corrib have indeed the highest number of benthic invertebrates. While I agree with part of their following conclusions in the response, I have made clear those points with which I disagree. Overall, this is also not relevant for the monitoring of the success of the compensatory measures, and in consequence, there are no outstanding issues.

3.8 Question 8:

Please comment upon and explain the rationale for picking the location of sampling spots at Mweeloon as indicated on figure 3.2 of appendix 8 of the Main Compensatory Measures Report.

A high-level explanation of the rationale for the decision of sampling sites has been provided. The location and coverage of the sampling points are in their current form appropriate for the purpose of the monitoring programme. There are no outstanding issues in relation to this question.

3.9 Question 9:

Concern is expressed that in its current form, the sampling strategy is not specific enough for the establishment of a baseline environment on which the success of future compensatory measures can be assessed. Please provide further details of a sampling strategy which will provide comprehensive data on a baseline environment on which before and after scenarios can be established, and how these will be compared.

A new sampling strategy for intertidal habitats was proposed by the applicant. This is based on the use of reference areas, which will enable a comparison of the biological communities in the target habitats before and after the implementation of the compensatory measures. The sampling strategy for the stony bank and saltmarsh habitats is in my opinion fit for purpose. In relation to the monitoring strategy for intertidal habitats, this is discussed in some detail in my comments on the response to question 10.

3.10 Question 10:

The Board have concerns that the monitoring programme for the intertidal habitats has some significant methodological errors, such as samples taken at different times of the year, with five replicas taken in Tawin Island (correct for statistical analysis), and only

two samples provided at Renmore (not correct). The results of the two samples are compared for analytical purposes in the report. The Board recommend that any inferred results are based on more consistent and robust data set.

Overall, this recommendation has been accepted by the applicant, with a proposal for a monitoring programme based on using references sites to compare temporal changes at a nearby oyster site where cultivation will continue and the fallowed sites – that is, the sites that will be subject to mitigation. This is in my opinion a correct approach, and a clear objective for the monitoring programme – comparison of benthic communities at the compensatory site and a reference site. The new monitoring programme includes taking 10 sediment samples for biological analyses and 10 sediment samples for chemical analyses at four intertidal locations. These include one location at an active and continuing oyster aquaculture site, at two oyster aquaculture sites where culture will cease (one of them adjacent to an area of intensive agriculture, the other adjacent to an area of organic agriculture) and on the route of the tractor used for aquaculture activities and traffic. The proposed monitoring programme includes taking samples before the trestles are removed, which would be the baseline data, that is, a benchmark for future comparison. Samples would also be taken a week after the removal of the trestles, one month , six months and one year post removal and once a year for the following four years (five years in total after removal).

It is not clear in the method why they consider it necessary to take samples one week, one month and six months post-removal. In my opinion, a better monitoring option would be to take samples one year after stopping aquaculture activities followed by annual surveys over a period of five years. Changes in sediment chemistry and benthic community structure are likely to take several months to one year, considering reproductive cycles and seasonal variation. I would also recommend the use of replicate biological samples, in order to provide sufficient data to enable meaningful statistical analyses of trends of benthic communities. The use of at least triplicate samples taken for the baseline survey followed by surveys once a year in each of the 10 sampling sites after the initial baseline survey would provide a more robust method to detect changes in the benthic communities (JNCC 2018). It is important to consider that the number of replicates required needs to strike a balance between the statistical requirements for assessing certainty, the magnitude of change to be detected, and the

constraints imposed by the available resources (Ware & Kenny 2011). The rationale beyond the use of single samples has not been explained in the response, especially when considering that 2 replicate samples were taken in each one of the 10 sites in Renmore, and 5 replicate samples in each one of the 25 stations in Mweeloon.

Samples replication is especially important considering the size of the samples. Whilst the volume of the corers that will be used to take the samples is not given in Appendix 3.1, I would assume that these will be hand-held corers, which have limited volume capacity – cores of 15cm of diameter with a depth of 15cm were used to sample benthic communities in Renmore in October 2015 and Mweeloon in 2017. Presumably, corers of this size will be employed for the monitoring programme. The use of triplicate samples would ensure that the samples are minimally representative.

A different monitoring schedule could be used to monitor changes in the density of *Didemnum sp.* as the eradication programme is likely to produce changes in the short-term, and both sampling and analysis are faster and simpler than those required for infaunal benthos.

Another important point is that samples of benthic infauna for operational or investigative monitoring to support regulatory decisions must always be taken at the same time of the year. Contrary with what is stated in the applicant's response, benthic communities do experience seasonal variation – precisely the 'exception' of the annual reproductive cycle, as acknowledged in the response, is an important element of seasonal variability. Many infaunal benthic species experience seasonal reproductive patterns which dramatically alter the number of individuals present at different times of the year (JNCC, 2010; 2004b). Mortality during the winter can also affect benthic biomass and number of individuals (Beukema 1974; Zwarts and Wanink 1993; Coma *et al.* 2000). Research conducted in northern France (Saulnier *et al.* 2018) showed that populations of the polychaete worm *Nepthys hombergii* experienced significant seasonal abundance patterns at one site of the study area. This species was also found in samples from Renmore, according to Appendix 4.2 of the Compensatory Measures Report submitted by the applicant in April 2019.

For the above reasons, available guidance for benthic monitoring requires that ongoing surveys should be carried out at the same time of year as the baseline survey, or if the same month cannot be accommodated then sampling should be undertaken in the same season at least (Ware & Kenny 2011, JNCC 2018).

Response to question 10: Summary

In summary, whilst the new strategy proposed for monitoring intertidal benthic habitats is a significant improvement on the previous strategy, it is my opinion that it still requires further consideration. My advice is that replicate benthos samples should be taken, and that the surveys must be undertaken on the same season at least or ideally on the same month of the baseline survey. Mid to later summer would be an appropriate time for sampling intertidal benthic communities. Both use of replicate samples and consistency in the time of sampling are outstanding issues that require further discussion or compliance, if the Board decides to make these points conditional to permitting.

4. Conclusions

In general, most of the issues raised by the Board in their questions have been addressed by the responses provided by the applicant. These responses clarify the doubts and concerns raised, and provide further information on the proposed monitoring programme to validate the predictions made in relation to the outcomes of the compensatory measures.

Importantly, all elements of the monitoring programme have now clear objectives and appropriate targets and indicators. The methodologies proposed for the monitoring programmes for most of its components are fit for purpose. However, the methodology proposed for monitoring intertidal benthic communities require further modifications.

5. References

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