APPENDIX A4

Irish Water

Greater Dublin Drainage

Summary of Advice

Shellfish

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Qualifications and Role on the Proposed Project

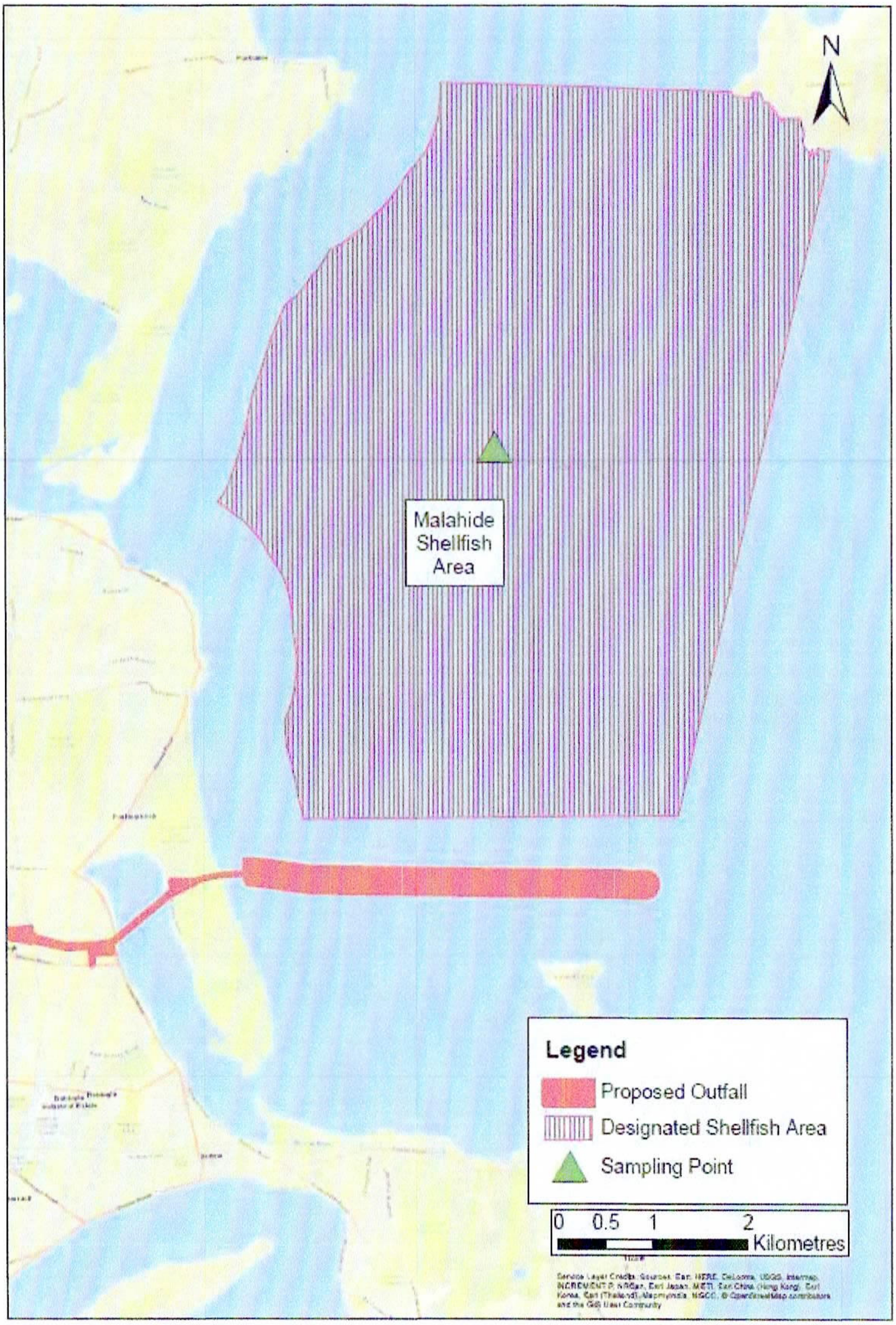
1. My name is Dr Marja Aberson and I am a Senior Marine Ecologist at Jacobs where I have over eight years professional experience in marine environmental consultancy. I have been involved with delivering marine environmental projects for a wide range of infrastructure projects in the UK, offering specialist advice on benthic ecology. I am a Chartered Biologist with the Royal Society of Biology and I have a combined Bachelor of Science honours degree in Marine Biology and Zoology from the University of Wales Bangor, a Master of Science in Coastal Zone Management from Bournemouth University and a Doctorate from Queen Mary University of London in Marine Ecology.

2. I have been involved in the Proposed Project since March 2019. At the request of my colleague Ciaran O'Keeffe, I undertook desk-based research to address Fingal County Council's (FCC) concerns on the potential impact of the discharge from the Proposed Project on the classification status of the Malahide shellfishery (razor clams). The research also focused on understanding how the levels of faecal coliforms (as measured by counts of the bacteria *Escherichia coli*) can be related to the uptake and concentration in shellfish. The findings are summarised in this Brief of Evidence.

The Malahide Shellfishery

3. Of the shellfish waters in the area, the Malahide production area (site name: DN-ME) is the closest one to the proposed outfall pipeline route. Here, harvesting for the razor clam *Ensis* sp. (predominantly *Ensis siliqua*) occurs over the winter months in the area. At the start of the Proposed Project's design in 2011, the Malahide Shellfish fishery was assigned a 'Class B' on the harvesting classification, but since then and currently holds an 'A Status'. The classifications criteria is outlined in Table 1, Appendix A.

4. At the time of conducting the research (March 2019) the Malahide production area had a status of 'Open', as determined by the result of the last sample of *E. siliqua* analysed (5 February 2019). The sample was collected as part of the HABs (Harmful Algal Blooms) Shellfish Monitoring Programme.


N
Malahide
Shellfish
Area
Legend
Proposed Outfall
Designated Shellfish Area
Sampling Point
0 0.5 1 2
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Shellfish Hygiene Standards in live bivalve molluscs

5. At present hygiene standards for live bivalve molluscs (LBM) (hereafter referred to as 'shellfish') are applied to concentrations of the bacteria *Escherichia coli* (*E. coli*) in the flesh of the organism and not the water column. Under Directive 2006/113/EC (repealed and incorporated in Directive 2000/60/EC, the EU's Water Framework Directive, since 2013) on the quality required of shellfish waters, there is a statutory guideline microbiological standard (SWD G) of 300 faecal coliforms per 100ml in shellfish flesh and intravalvular liquid (in 75% of shellfish samples). Concentrations of *E. coli* in flesh will also determine the classification of a production areas as either A, B or C. This regulates the treatment required before shellfish can be marketed for human consumption (Table 1, Appendix A).

***E. coli* uptake in shellfish in response to concentrations in seawater**

6. It can be difficult to directly quantify the relationship between *E. coli* concentrations in the water to the uptake and accumulation in the flesh of shellfish. Recent projects, undertaken by Cefas (Centre for Environment Fisheries and Aquaculture Science) in the UK have sought to:

   - explore the relationship between the microbial quality of shellfish flesh and seawater;
   - understand the dynamics of uptake and clearance of *E. coli* in shellfish subject to chronic contamination; and
   - identify water concentrations of *E. coli* which would be compliant with the current standards in the flesh of bivalve molluscs.

   This was done through desk-based assessments, microcosm laboratory studies and *in situ* environmental investigations coupled with hydrodynamic modelling, and the results of which are summarised below (paragraphs 7 to 12).

7. Concentrations of *E. coli* in seawater and in the flesh of mussels (*Mytilus* spp.) and oysters (*Ostrea edulis* and *Magallana gigas*) sampled across production areas in the UK by Cefas reported a positive linear relationship between increasing *E. coli* concentrations in the water and flesh. The level of contamination between the species was variable indicating inter-specific differences in uptake. The overall high variability found in the data may be expected in the naturally variable environmental conditions in which these samples had been sourced (*Project WT1001* Cefas, 2011).

8. Cefas microcosm experiments monitored uptake in the mussel *Mytilus edulis,* the oyster *M. gigas,* and the cockle *Cerastoderma edule,* exposed to chronic exposure (continuous dosing for five days) to a range of water quality levels (1 cfu/100ml – 330 cfu/100ml). A rapid uptake of *E. coli* was shown for all species to a maximum 'equilibrium' (plateau state) within 17 hours, and on cessation of dosing, a rapid clearance was also exhibited (*Project WT093* Cefas, 2013). There is a threshold for *E. coli* concentrations in the water above which bivalves are unable to accumulate more bacteria, however, this maximum 'equilibrium' state will vary between both individuals and species (*Project WT1001* Cefas, 2011).

9. These microcosm experiments found that although flesh concentrations increased linearly with concentrations of the tank seawater, there was no direct association with an increase in seawater concentrations of the microcosms and resulting accumulation factor. Accumulation rates ranged from 11.7 for *M. gigas,* 15.2 for *M. edulis* and 330 for *C. edule.* The rate of clearance following the end of dosing was not as proportionate to the changes in water column and rate of accumulation in tissues. Bacteria can be rapidly cleared from shellfish when exposed to clean waters, with an initial phase of greatest clearance lasting <10hrs (*Project WT093* Cefas, 2013).

10. Environmental investigations were undertaken to verify whether the results implied by the microcosm experiments could be confirmed in shellfish waters (*Project WT093* Cefas,2013). It was found that the relative ordering in inter-species *E. coli* accumulation remained valid with other studies and the microcosms. However, no clear statistically significant difference between mean *E. coli* concentrations between the three species sampled from these environmental investigations were reported, only in comparison with *E. coli* seawater concentrations. The wide variation in concentrations recorded in these waters and flesh supported the wide variability also reported from naturally sampled concentrations under *Project WT1001* (Cefas, 2011).

11. As direct measurements of water quality in those environmental investigations did not significantly correlate with *E. coli* shellfish concentrations, hydrodynamic modelling for predicted *E. coli* concentrations was done for near-real-time predictions relative to where the shellfish bags had been positioned. No statistically

significant correlation between water quality and the laid shellfish was found. However, diurnal and tidal patterns in concentrations were found to be important, indicating a ubiquitous and high 'natural' variability in *E. coli* concentrations, with differences exceeding 2 10-base logarithm orders diurnally even under dry conditions. It was concluded that such short-term variability in bacterial concentrations may now be considered the 'normal' condition (Cefas, 2013).

Indicative water quality standards

12. Based on the results of these Cefas projects, indicative thresholds for *E. coli* water concentrations for mussels, oysters and cockles were predicted, so to meet compliance with SWD G (≤300 cfu/100g) and the harvesting classifications A (<230 cfu/100g) and B (<4,600 cfu/100g). Indicative water concentrations for each of the three types of bivalves and 'all species combined' to meet the SWD G and class A standards for flesh concentrations are shown in Table 2 and Table 3, respectively (Appendix B). On examination of the indicative standard values it is apparent that there are a wide range of predicted thresholds for concentrations of *E. coli* in seawater in order to meet compliance.

***E. coli* uptake in razor clams**

13. There has been very little research undertaken on the uptake of *E. coli* in razor clams in comparison to other commercial species (e.g. the mussel *M. edulis*), and sensitivity assessments of this bivalve group to environmental pressures, currently has a paucity of evidence on responses to biological pressures (Hill, 2006). An important knowledge gap was identified by Cefas for *Ensis* spp. (Cefas, 2014) which was further validated in this recent research exercise.

Conclusions

14. Although there is often a clear linear relationship between concentrations of *E. coli* in seawater versus shellfish, at present there remains no agreed upon *E. coli* seawater concentration guideline value in which to monitor against. Studies have shown that for compliance there can be wide range in predicted *E. coli* concentrations calculated, that is primarily dependent upon the targeted species in question and methods of assessment (artificial microcosm verses natural environment). As such these studies have not supported the application of a single guideline value for water quality where research has focussed on only a few commercial species, and which currently has not included the razor clam *Ensis* spp.

15. A review by Cefas (2014) has attempted to assess the evidence for potential use of indicator species to classify shellfish production areas. It was concluded that the mussel *Mytilus* spp. may be used as an indicator in many situations, but an indicator approach may not be recommended at this stage for representation of *Ensis* spp. due to no supporting data available. Due to the paucity of data, it will be imprudent to estimate a potential accumulation factor in the tissues of razor clams as current work has shown a wide range of uptake rates and maximum concentrations between bivalve species, and with spatial-temporal differences also expected.

16. In consideration of the proximity of the proposed outfall pipe from the Proposed Project to the receiving shellfish waters, the current classification of A and the scarcity of data on *Ensis* spp., a precautionary principle should be applied for assessing the risk to the Malahide razor clam fishery. It is therefore recommended that Irish Water should seek to meet the Cefas indicative threshold value for 'all species' throughout the shellfishery (Table 3, Appendix 2).

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References

Cefas, 2011. Relationship between the microbial quality of shellfish flesh and seawater in UK harvesting areas. *Project WT1001 Factors affecting the microbial quality of shellfish.* Cefas report to Defra. 33 pp.

Cefas, 2013. Impact of chronic microbial pollutions on shellfish. *Project WT093.* Cefas/CREH report to Defra. 88 pp.

Cefas, 2014. A critical review of the current evidence for the potential use of indicator species to classify UK shellfish production areas. Report No. FS512006. 83 pp.

Hill, J.M., 2006. *Ensis ensis* A razor shell. In Tyler-Walters H., and Hiscock, K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 07-03-2019]. Available from: https://www.marlin.ac.uk/species/detail/1419.

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https://webapps.marine.ie/HABs/AreaStatus/AreaStatusSummary?locationId=44&locationNameCode=Malahide%20%20(DN-ME)&locationType=Onshore&isFinfish=false [Accessed 21.05.19]

Sea-Fisheries Protection Authority (SFPA), 2017. Code of Practice for the Microbiological Monitoring of Bivalve Mollusc Production Areas (COP SH01) Version 6 May 2017.

Appendix A

Table 1: Criteria for the classification of bivalve mollusc harvesting areas under Regulation (EC) no 854/2004, Regulation (EC) 853/2004 and Regulation (EC) 2073/2005. Table extracted from Code of Practice for the Microbiological Monitoring of Bivalve Mollusc Production Areas (SFPA, 2017)

Classification	Standard per 100g of LBM flesh and intravalvular fluid	Treatment required
A	<230 *E. coli* per 100g of flesh and intravalvular liquid (*)	None
B	Must not exceed the limits of a five-tube, three dilution. Most Probably Number (MPN) test of 4,600 *E. coli* per 100g of flesh and intravalvular liquid (**).	Purification, relaying in class A or cooking by an approved method.
C	Must not exceed the limits of a five-tube, three dilution MPN test of 46,000 *E. coli* per 100g of flesh and intravalvular liquid.	Relaying for a long period or cooking by an approved method.
Prohibited	>46,000 *E. coli* per 100g of flesh and intravalvular fluid.	Harvesting not permitted.

(*) Samples must not exceed, in 80% of samples collected during the review period, 230 *E. coli* per 100g of flesh and intravalvular liquid. Remaining 20% must not exceed 700 *E. coli* per 100g of flesh and intravalvular liquid.

(**) Area may remain classification B for which relevant limits of 4,600 *E. coli* per 100g are not exceeded in 90% of samples.

Appendix B

Table 2: Indicative concentrations of *E. coli* in seawater (geometric mean and 90th percentile) to achieve annual 75% compliance with standard for SWD G (500 cfu/100g) in shellfish

Species	Study Type	Geometric mean Seawater cfu/100ml	90th percentile seawater cfu/100ml	Sample size	Reference
Mussels *Mytilus* spp.	Natural sampling	8.9	102	313 individuals (pooled sites)	Cefas (2011)
Mussel *M. edulis*	Microcosm	10	38	predicted from 12 samples taken per annum	Cefas (2013)
Oyster *M. gigas*	Natural sampling	41	492	111 individuals (pooled sites)	Cefas (2011)
Oyster *M. gigas*	Microcosm	13	100	predicted from 12 samples taken per annum	Cefas (2013)
Oyster *O. edulis*	Natural sampling	8.3	64	178 individuals (pooled sites)	Cefas (2011)
Cockle *C. edule*	Microcosm	0.26	2.5	predicted from 12 samples taken per annum	Cefas (2013)

Table 3: Indicative concentrations of *E. coli* in seawater (geometric mean and 90th percentile) to achieve annual 80% compliance with standard for harvesting Classification A (Cefas, 2013).

Species	Study Type	Geometric mean seawater cfu/100ml)	90th percentile seawater cfu/100ml	Number of samples / annum
Mussels (*Mytilus* spp.)	Microcosm	5.5	20	12
Pacific oysters (*M. gigas*)	Microcosm	7	52	12
Cockles (*C. edule*)	Microcosm	0.12	1.2	12
All species	Microcosm	1.4	20	12