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Redcastle licensed
Disposal SiteProposed
McKinney's Bank
Disposal Site

Port of Londonderry

Lough Foyle

Lisahally Berths

Limavady

Londonderry / Derry

DREDGING AND DISPOSAL AT LOUGH FOYLE, NORTHERN IRELAND

ABSTRACT

The Port of Londonderry is located at the point of discharge of the River Foyle into Lough Foyle, the lake on the western boundary of Northern Ireland, and is an important strategic business in the North of Ireland, which serves the entire region and promotes economic growth and stability. Historically the Port disposed of the entirety of its dredging requirement at the "traditional" disposal site within Lough Foyle. Because of changes in the dredging regime, new licensing was required. The local shellfisheries then objected to the increase in disposal at the currently used inshore disposal site at Redcastle and expressed a preference for alternative sites, principally McKinney's Bank. The Port with the shellfishery industry undertook to apply for the alternative (McKinney's Bank) site and an additional modelling exercise was then commissioned for this alternative site. The monitoring programme demonstrated that the changed regime of regular small-scale dredging and disposal of all dredged sediments at the new McKinney's Bank disposal site has no significant detectable effect on water quality or seabed sediment characteristics within the Lough (lake), other than within the immediate environs of the licence area. It also demonstrated clearly the numerous benefits to the disposal of dredged material within the Lough.

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INTRODUCTION

The Port of Londonderry is located at the point of discharge of the River Foyle into Lough Foyle, the lake on the western boundary of Northern Ireland (opening photo) and is an important strategic business in the North of Ireland, which serves the entire region and promotes economic growth and stability. Historically the Port disposed of the entirety of its dredging requirement at its "traditional" disposal site within Lough Foyle. This site had been in use since the 19th century and was centred at approximately 55° 09.5' North,

Above: A Google Earth image of the North coast of Northern Ireland, with top left the north Atlantic Ocean and top right the Channel. The Port of Londonderry is located at the point of discharge of the River Foyle into Lough Foyle on the western boundary of Northern Ireland.

007° 04.5' West; it is still shown on the current Admiralty navigation charts although it is annotated as disused (Figure 1).

Until 1977, when the Port's bucket dredger and self-propelled hoppers were withdrawn from service, quantities in the range of 86,220 m³ to 180,090 m³ of mixed dredged materials were disposed of at the traditional site and in 1977/78 1.055 million m³ were disposed of with no adverse effects within Lough Foyle. In 1982 a volume of 324,750 m³ and in 1983 some 263,053 m³ were removed from the channels and berths and were either disposed of at the traditional site or else dispersed during dredging. That is, this large volume of material remained within Lough Foyle.

Routine maintenance dredging from 1984 to 1994 was sporadic and was considered unlikely to have exceeded 100,000 m³ per annum. In 1993/94 the Port moved its main base of operations from the constrained confines of the city to new berths and shore facilities at Lisahally. The new facility was supported by a deepened access channel through Lough Foyle (see Figure 2), which was dredged during the winter of 1993/94.

In support of the new access channel, 2D mathematical modelling was undertaken and



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ANTHONY BATES

(CEng, MICE) is a Chartered civil engineer and senior partner in specialist dredging consultants Anthony D Bates Partnership. Together with his partners, he provides advice in dredging and related projects across the world, mainly to ports and harbours, but also to industry, governments, water authorities, law firms and private companies. He has served on a variety of professional committees and PIANC working groups. Today he focuses mainly on expert witness assignments and input to projects where his experience is of special value.



ROBIN MORELISSSEN

received his MSc degree in Civil Engineering from the University of Twente, The Netherlands. Since 2001, he has been working at Deltares as a senior researcher/consultant on coastal hydrodynamics, outfalls and dredging-related topics. He has a wide experience in (multi-disciplinary) projects world-wide concerning coastal hydrodynamics and marine impacts. He also has a key role in developments around the coupling of near and far field models and advanced modelling techniques in engineering practice used in dredge plume studies and recirculation studies for industrial outfalls.



CAROLINE ROCHE

obtained her PhD in 2004 in Marine Science from the National University of Ireland, Galway. Her PhD thesis focused on the impacts of dredge material disposal on a disposal site in Inner Galway Bay. Since then she has been working with AQUAFAC International Services Ltd., an environmental consultancy based in Galway. She has consulted on a variety of projects including dredging and disposal operations, offshore wind farms and harbour developments and specialises in assessing the impacts of human activity on the benthos.

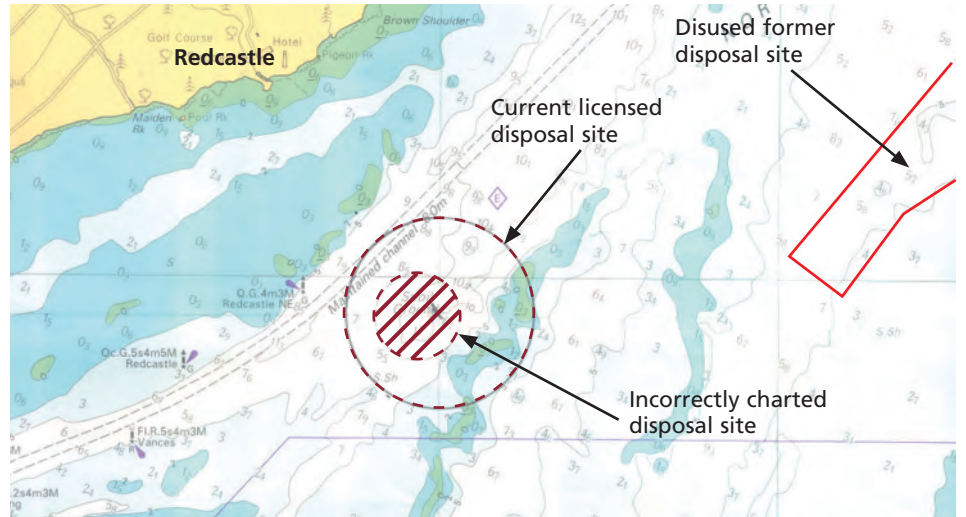


Figure 1. Location of Current Redcastle Disposal Site. Large Circle shows Actual Licensed Area.

a variety of options for disposal were investigated including land reclamation and beach recharge. One of the favoured sites for disposal was near to the mouth of the Lough at McKinney's Bank (Figure 2). Modelling proved that the proposed McKinney's Bank site would have been suitable for disposal of whatever arose from the capital dredging without causing any adverse effects within the Lough.

However, following objections from the Lough's fishing industry, an agreement was reached that the capital dredged materials (a paid volume of some 728,060 m³) be disposed of at sea far outside of the Lough (Figure 2). This action removed material from circulation

within the Lough Foyle sediment cell and the Natural Heritage Directorate (the predecessor of the Northern Ireland Environment Agency) objected strongly to the material being removed and lost to the sediment system, but the views of the fishermen prevailed.

Since the deepening of the access channel, the Port has had a regular maintenance dredging requirement for the channel amounting to about 95,000t annually which has been disposed of mainly (80,000t) offshore by contract dredgers with the balance (15,000t) being disposed of at the Redcastle disposal site (shown at the centre of Figure 1) by the Port's own dredger.



Figure 2. Location of Dredging Site, McKinney's Bank and the Licensed Offshore Disposal Site.



Figure 3. The Port of Londonderry's trailing suction hopper dredger *Lough Foyle*.

The major part of the maintenance dredging has been undertaken by contract dredgers in single campaigns as required by conditions within the Port and Harbour, with a smaller amount removed by the Port's own dredger – originally the *Mary Angus* and, now, the *Lough Foyle* – to keep the channel clear between the more substantial and more general contract maintenance dredging campaigns. No contract dredging has been carried out since the Port acquired the *Lough Foyle* in 2010. Until recently, sand dredged by the Port dredgers was not disposed of, but is landed ashore for beneficial use.

The current inshore site at Redcastle within Lough Foyle has been licensed since 1995 for the disposal of 15,000t annually by the Port's own small dredger so that the Port can deal with the smaller amounts of continuous maintenance dredging for which contract dredging would be prohibitively expensive. Consequently, the Port now utilises two licensed disposal sites:

- offshore at 55° 17.5' North, 06° 40.0' West, and
- inshore at 55° 08.9' North, 07° 06.5' West (the Redcastle site).

The location of the current Redcastle site was established after extensive consultation with, amongst others, the Foyle Fisheries Commission and the Greencastle Fishermen's Cooperative Society, and the Foyle Shellfish

Cooperative after trial shellfish dredging in 1994. The trial shellfish dredge established that the nearest known shellfish beds were located 1000 m (oysters) and 3500 m (mussels) away and it was concluded (Anthony D Bates Partnership, 1994) that the site was the best practicable environmental option (BPEO). Despite establishing the disposal site in dialogue with the Lough Foyle fishing industry much commercial shellfishery development has subsequently taken place up to and, it is understood, even within the boundaries of the licensed disposal site.

Note that the existing Redcastle licensed sediment disposal site is not correctly shown on the current Admiralty Chart 2511 in respect of either location or size (see Figure 1). It is incorrectly charted as a 400-m diameter circle with its centre 100 m east of the licensed location but its licensed size is actually much bigger; it is a 0.25 nautical mile radius (926-m diameter) circle. The disposal of maintenance material at the two existing (Redcastle and offshore) sites was previously covered by the issue of two separate licences but, more recently and logically, has been amalgamated under a single licence.

PROPOSALS TO EXPAND USAGE OF THE REDCASTLE DISPOSAL SITE

As mentioned above, the Port recently purchased the trailing suction hopper dredger renamed *Lough Foyle* (previously, *Saeftinge*) (Figure 3),

which is outfitted with bottom doors. This vessel is capable of maintaining the channel depth of the Port's recent annual requirement of 80,000t without the need for periodic contract dredging. The offshore disposal site (see Figure 2), which has taken the majority of the dredged sediment since the Lisahally berths were created, is a round trip of approximately 65 km from the Redcastle disposal site with consequentially substantial energy consumption and associated carbon emissions. Therefore, to keep sailing times, and hence costs, down the Port has sought (from 2008 to 2010) to re-establish the former practice of disposal within the Lough.

In practice, this would mean the disposal of up to 80,000t annually at the Redcastle site. However, dredging and disposal would be regular – no more than one trip per day, five days per week – such that no more than a couple of thousand tonnes a week would be relocated within the Lough. This is in sharp contrast to the contract dredging situation, when up to 15,000t was sometimes disposed of within the Lough in only a few days.

The proposal to keep the dredged sediment within Lough Foyle would be in line with the stated preference of the NIEA's predecessor (Connor J, 1995) and various official bodies, "... to retain dredged sediment within the coastal cell or sediment transport system from which it is removed." It is, however, a change from recent practice and would require going through the full FEPA (Food and Environmental Protection Act) licensing process.

THREE-DIMENSIONAL MODELLING

An extensive data collection and modelling exercise (Deltares, 2009) was conducted from 2008 to 2009. A dedicated Delft 3D-FLOW model was developed for Lough Foyle with a high level of detail in the areas of interest (i.e., dredged sediment disposal sites). To demonstrate the predictive value of the hydrodynamic model, the model was calibrated and validated with field measurements of water levels and three-dimensional current measurements (see Figure 4, which shows a vector plot and comparison with the model current predictions and field measurements). These measurements were collected in transects around the area of interest in a survey campaign dedicated to this study.

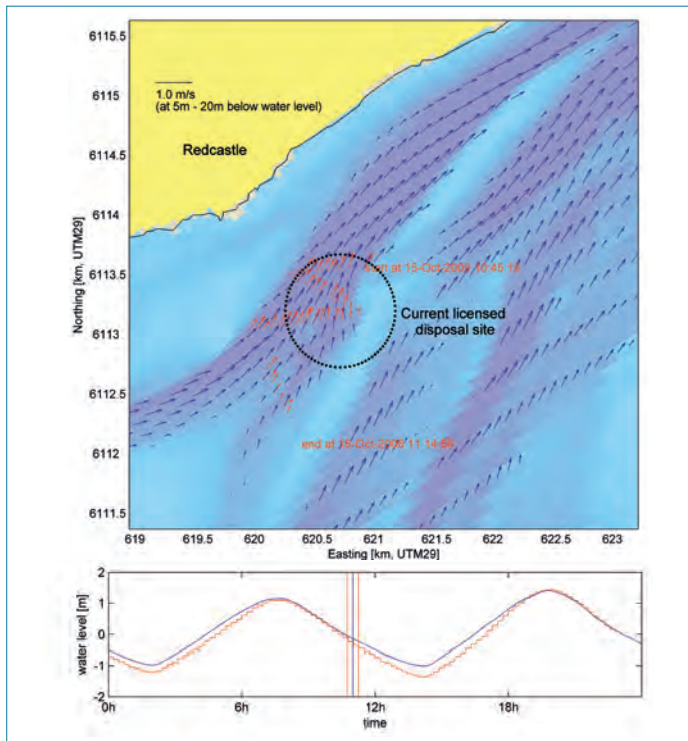


Figure 4. Samples of Model Current Vector Plots, and a Comparison of Model Current Predictions and Field Current Measurements.

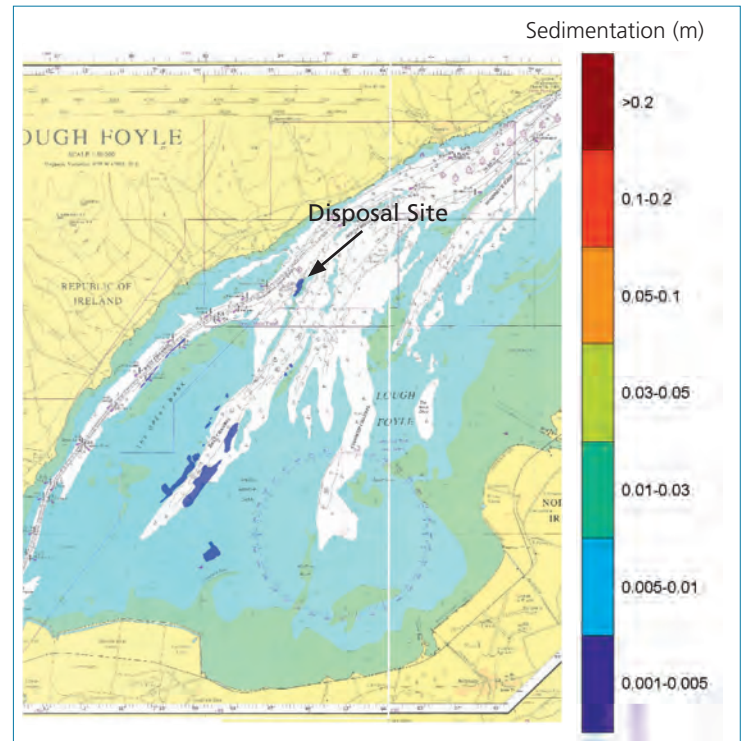


Figure 5. Sedimentation in Metres after One Year (15,000 tonnes Silt disposed of at Redcastle).

Furthermore, other data sources, including water level data, salinity data (conductivity, temperature and density (CTD) profiles) and sediment concentration data, were used to further validate the model's predictive value. This calibration and validation has demonstrated that the developed model was very capable of replicating the present behaviour of the natural system and predicting expected future effects of proposed different dredging regimes.

The modelling exercise presented the existing situation (15,000t per annum) and showed the patterns of redistribution of sediment within Lough Foyle from the disposal ground at Redcastle as an "excess" quantity above background levels (see Figure 5). Other simulations were carried out for the situation of 60,000t and 80,000t disposed of annually at Redcastle.

The modelling showed that as a result of the infrequent sediment discharges at the disposal site location in the new regime, the dredging-induced suspended sediment concentrations can be increased in the direct vicinity of the disposal site, but only for short periods. Lower

suspended sediment concentrations are expected compared to the existing dredging regime involving a contractor dumping high volumes in a short period of time. Because of the increased amount of annually discharged sediment, the sedimentation as a result of the new dredging regime inevitably shows an increase compared to the old regime.

The model showed that the impacts of increased sedimentation >10mm were mainly restricted to an area local to the disposal site (see Figure 6). The majority of the additional annual sedimentation is expected in the East channel, with a typical layer thickness of 5 mm.

Because the local shellfisheries objected to the increase in disposal at Redcastle (see below), additional modelling of disposal at a potential alternative site at McKinney's Bank was required. The sedimentation pattern after one year (long-term simulation) of disposal of 80,000t at McKinney's Bank is presented in Figure 7.

In this case, approximately 50% of the discharged sediments are predicted to be transported out of the Lough because of the close vicinity of the Lough's entrance. The

modelling shows that after one year, the excess sedimentation resulting from the full dredging operation is limited to a number of patches with sedimentation over 1 mm on shallow areas inland of the disposal site and on the north shore of the Lough and that the discharged sediment will be transported away from the disposal site. A few patches are expected to have a local sediment layer thickness up to a few tens of millimetres, but most patches will have a thickness of a few millimetres.

THE REGULATORY CONTEXT

Sediment contamination

The normal regulatory process for the disposal of dredged sediment requires a demonstration that the sediment is within acceptable limits set out by OSPAR (Convention for the Protection of the Marine Environment of the North East Atlantic). This is done by testing sediments for their physical and chemical properties. Samples were taken for testing from the access channel (see Figure 8), which is the source of the proposed maintenance dredging.

The samples were tested and tested against the widely accepted CEFAS "Action Levels"

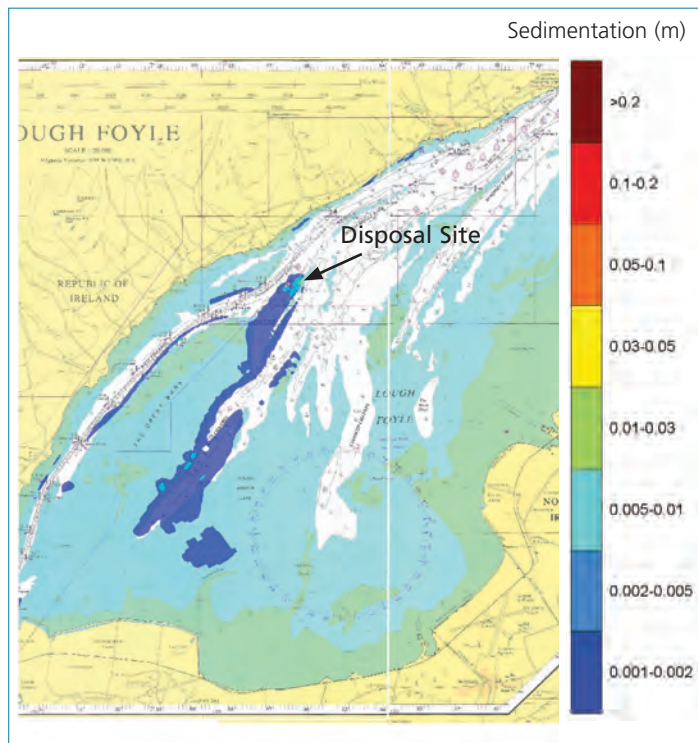


Figure 6. Sedimentation in Metres after One Year (80,000 tonnes Silty Sand disposed of at Redcastle).

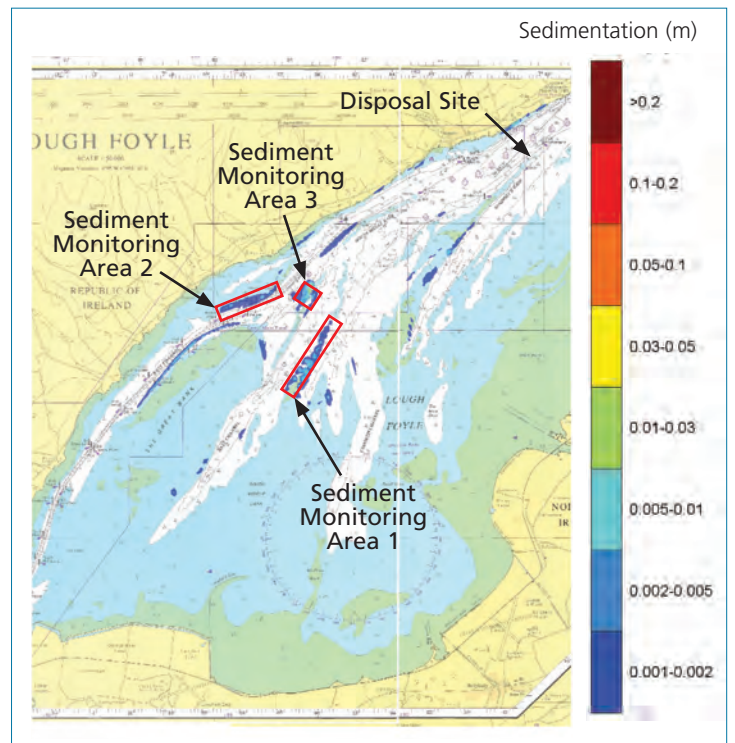


Figure 7. Sedimentation in Metres after One Year (80,000 tonnes Silty Sand disposed of at McKinney's Bank).

shown in Table I (CEFAS is the UK Government's Centre for Environment, Fisheries and Aquaculture Science). The CEFAS guideline action levels for the disposal of dredged material are not statutory contaminant concentrations for dredged material but are used as part of a weight of evidence approach to decision-making on the disposal of dredged material to sea. Table II shows the results of the testing.

ENVIRONMENT AND FISHERIES

After the modelling was complete, a presentation was made to principal consultees – NIEA (Northern Ireland Environment Agency), DARD (Department of Agriculture and Rural Development) and the Loughs Agency. The Loughs Agency recommended that the Port discuss the results with the commercial shellfisheries and open a dialogue. This was done, but despite the prediction of only minor impact, the shellfisheries expressed a preference for alternative sites, principally McKinney's Bank. This is approximately the same location rejected by fishery industry for disposal of capital dredging in 1993. It is important to note that the new site now proposed was identified by the shellfishers themselves. The Port undertook with the

shellfishers to apply in the future for the alternative (McKinney's Bank) site and an additional modelling exercise was then commissioned for this alternative site.

Notwithstanding the preference expressed by the shellfishery industry for an alternative site,

an application was made for disposal of all the Port's 80,000t of maintenance dredging at the existing Redcastle disposal site because it was feared that unresolved national (Ireland/ United Kingdom) jurisdiction concerns at the proposed new McKinney's Bank site would delay licensing.

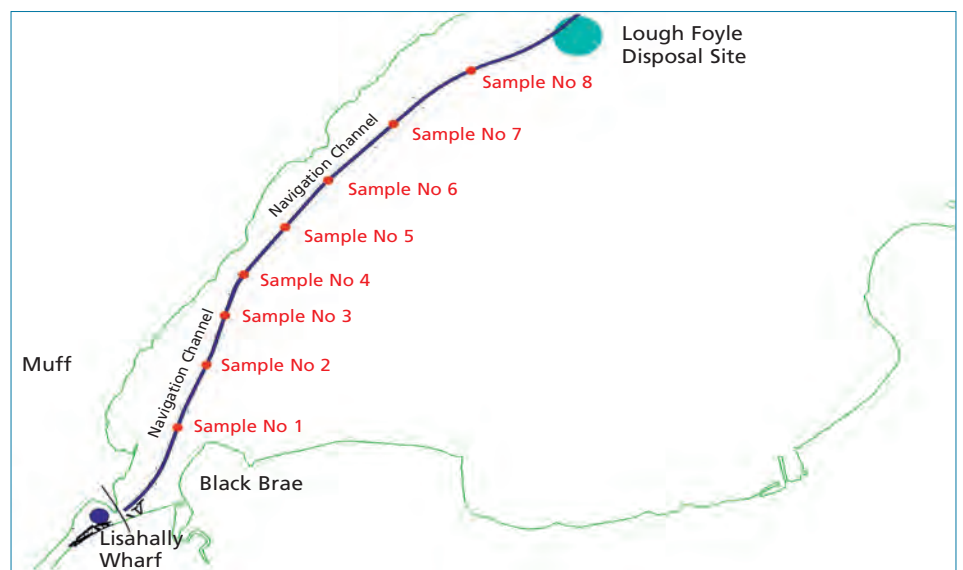


Figure 8. Locations of Access Channel Sediment Samples.

The fishery industry's expected objections to this licence application were received and a meeting to discuss the situation was attended by NIEA, LPHC, the Loughs Agency and the Port's consulting engineers, Anthony D Bates Partnership (ADBP). At the meeting, a compromise FEPA Licence for 30,000t annual disposal in Lough Foyle was agreed upon together with the agreement to proceed with an application for full disposal at McKinney's Bank.

Ultimately, however, the monitoring requirements attached to the 2010 FEPA Licence for disposal of 30,000t annually at the current Redcastle site proved financially too onerous for the relatively small increase in disposal tonnage and the Port decided therefore to revert to the previous licensed tonnage, which did not require monitoring to be conducted. The 2010 FEPA Licence was accordingly varied back to 15,000t at Redcastle and 65,000t offshore.

ENVIRONMENTAL CONSIDERATIONS AT REDCASTLE

CEFAS had carried out a baseline survey of the shellfish resource in Lough Foyle on behalf of the Loughs Agency in 2007. Figure 9 shows a distribution map of oyster and mussel grounds resulting from the CEFAS study. Oyster ground was typified not only by the presence of oysters but also of suitable shell cultch.

Large areas of the Lough are in use for mussel relaying (i.e., farming) and there are also considerable stocks of wild mussels either naturally settled or remnants of previous relaying exercises. Mussels are relaid onto ground that has been cleaned by (mussel) dredging. A total of approximately 32% of the Lough's entire surface area is occupied by relaid mussels, a quarter of which was considered unproductive (CEFAS, 2007). Approximately 42% of the Lough can be characterised as oyster grounds, more than half of which contained significant amounts of oysters during the 2007 CEFAS survey.

Additional species such as green crabs (*Carcinus maenas*), whelks (*Buccinum undatum*), cockles (*Cerastoderma edule*), palourde clam (*Tapes senegalensis*) and the trough shell (*Spisula solida*) were recorded during the CEFAS (2007) survey.

Table I. CEFAS Contaminant Action Levels.

| Contaminant | Action Level 1 (µg/g wet weight) | Action Level 2 (µg/g wet weight) |
|-------------------------------|-------------------------------------|-------------------------------------|
| Arsenic (As) | 10 | 25-50 |
| Mercury (Hg) | 0.15 | 1.5 |
| Cadmium (Cd) | 0.20 | 2.5 |
| Chromium (Cr) | 20 | 200 |
| Copper (Cu) | 20 | 200 |
| Nickel (Ni) | 10 | 100 |
| Lead (Pb) | 25 | 250 |
| Zinc (Zn) | 65 | 400 |
| Organotins (TBT, DBT, MBT) | 0.10 | 1.0 |
| PCBs Sum of ICES 7 | 0.010 | – |
| PCBs Sum of ICES 25 congeners | 0.020 | 0.20 |
| Oil (petroleum hydrocarbons) | 100 | – |
| Sum of DDT | 0.001 | – |
| Dieldrin | 0.005 | – |

The existing disposal area is located on potential oyster ground, relaid mussel ground and undifferentiated ground. The disposal of sediment on any of these grounds will impact on the resident fauna within the area. While the proposed quantities of sediment (60,000t or 80,000t annually) are larger than is disposed of currently (15,000t), given the much larger timeframe over which the sediment is disposed of in the proposed new disposal regimes, tidal movements and variation in individual cargo

disposal locations, the depth of sediment in the disposal site at any one time will not vary from what is present under the existing regime (approximately 1.0-1.5 m). The larger quantity of sediment disposed under the proposed new disposal regimes will result in a larger quantity of sediment being dispersed over the Lough over a one-year period. However, these levels are all less than 10 mm deep. The specific impacts of this sediment dispersal on the key shellfish species is discussed below.

Table II. Sediment Sampling Results.

| Contaminant / Compound | Sample 1 | Sample 2 | Sample 3 | Sample 4 | Sample 5 | Sample 6 | Sample 7 | Sample 8 |
|------------------------|----------|----------|----------|----------|----------|----------|----------|----------|
| Mercury | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Aluminium | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Arsenic | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Cadmium | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Chromium | ✗ | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Copper | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Lead | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Nickel | ✗ | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Zinc | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| PCBs | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Organotins | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

Notes: Tick indicates below CEFAS Action 1 Levels.

Cross indicates exceedance of CEFAS Action Level 1 but still substantially below CEFAS Action Level 2.

Table III. Summary of Critical Thresholds for Oyster (*Ostrea edulis*) Beds.

| Species | Parameter | Optimum Range | Maximum Tolerated |
|----------------------|--------------------|------------------------------------|---|
| <i>Ostrea edulis</i> | Suspended sediment | <100 mg/l | Tolerant of short periods of high turbidity. 750 mg/l (larvae) |
| | Sedimentation | <3 mm (larvae after attachment) | 10-20 mm (adult) 1-2 mm (larval settlement) |

Table IV. Summary of Critical Thresholds for Mussel (*Mytilus edulis*) Beds.

| Species | Parameter | Optimum Range | Maximum Tolerated |
|-----------------------|--------------------|--|---|
| <i>Mytilus edulis</i> | Suspended sediment | 50-100 mg/l <250 mg/l (5 weeks) <400 mg/l (turbid estuaries) | <1867 mg/l (field) <10,000 mg/l for 3 weeks (adult in lab conditions) |
| | Sedimentation | | 10-20 mm (short time) |

Oysters

Oyster larvae appear to tolerate relatively high suspended sediment concentrations, as high as 400-800 mg/l (Germano and Cary, 2005). They require a clean, hard substratum (e.g., oyster shell or shell cultch) for attachment, but can tolerate thin layers of deposited sediments, perhaps up to 1 mm. After attachment, oyster larvae can tolerate deposition of 2-3 mm, but thicknesses >3-5 mm are likely to have some negative effects (Germano and Cary, 2005). Table III summarises the tolerance thresholds for oysters.

Adult oysters will not be affected by the dredging plume, as excess turbidities >10mg/l are not sustained more than 5% of the time (over a 14-day spring-neap tidal cycle) almost anywhere in the Lough and sedimentation nowhere reaches lethal levels for adult oysters (see Table III), except at the disposal site and its immediate vicinity.

Larval settlement of oysters (which usually takes place during the summer months: June-September) is, however, sensitive to sedimentation levels greater than 1-2 mm (Table III). The model calculations show that in both proposed disposal regimes at Redcastle (i.e., 60,000t and 80,000t annually), this sedimentation threshold is exceeded over an area of approximately 10-15 km² within the Lough (Figure 6), partly overlapping with some of the current and potential oyster

grounds (Figure 9). However, note that the threshold is also exceeded in the current disposal regime, although in a smaller area, but this has not impeded recruitment of oysters to date (CEFAS, 2007).

Furthermore, modelling results should be considered against the prevailing natural background sedimentation in the area, which could be in the same order of magnitude or more. In addition, storm events in the Lough, which is mostly rather shallow, are expected to wipe the oyster shells clean of built-up sedimentation.

Mussels

Previous studies on the effects of suspended sediments on adult mussels (*Mytilus edulis*) have shown that they are capable of coping with extreme high concentrations of suspended material (Kiørboe *et al.*, 1980). The ability for mussels to effectively utilise suspended food particles for growth is optimal at concentrations below 50 mg/l and concentrations above 100 mg/l result in weight loss (Prins and Smaal, 1989).

Mussels can protect themselves from overloading by temporarily closing their valves and when given sufficient time (months), which may be expected to be the case in Lough Foyle, they can adapt their gills and palps to higher concentrations of suspended

matter. The tolerance thresholds of mussels are summarised in Table IV.

Mussels are very tolerant of extremely high turbidities (see Table IV). Although incidental excess turbidities higher than 100 mg/l do occur near the disposal site (see Figures 6 and 9), excess turbidity never exceeds 10 mg/l for more than 5% of the time (over a 14-day spring-neap tidal cycle) except in a very small area near the disposal location. This will not have any impact on mussels (adults, larvae or spat).

Increased Disposal at Redcastle Site

The model demonstrated, in the main, the viability of disposal at Redcastle. Some concerns about the spat of native oysters were raised but these could potentially have been overcome by the implementation of a closed season. Sedimentation nowhere reaches lethal levels for mussels, except at the sediment disposal site and its immediate vicinity. Impacts of the dredging plume on mussel beds in Lough Foyle are therefore considered negligible.

ENVIRONMENTAL CONSIDERATIONS AT ALTERNATIVE MCKINNEY'S BANK DISPOSAL SITE

Figure 7 shows the sedimentation in metres after one year following the disposal of 80,000 tonnes of sandy silt at McKinney's Bank. (For ease of reference, the locations of sediment monitoring sites imposed by the licence are also shown on this image to show their correlation with predicted sediment areas.)

Oysters

Adult oysters will not be affected by the sediment plume, as excess turbidities >10 mg/l are not sustained for more than 5% of the time (over a 14-day spring-neap tidal cycle) almost anywhere in the Lough, and sedimentation nowhere reaches lethal levels for adult oysters. Larval settlement of oysters (which usually takes place during the summer months, June-September) is, however, sensitive to sedimentation levels >2 mm. The model calculations show that this threshold is exceeded over an area up to approximately 5 km² within the Lough, overlapping only for a small part with potential oyster grounds. Therefore, relocating the disposal site to McKinney's Bank causes no significant impact on oysters. In fact, the relocation of the disposal site would result in significant

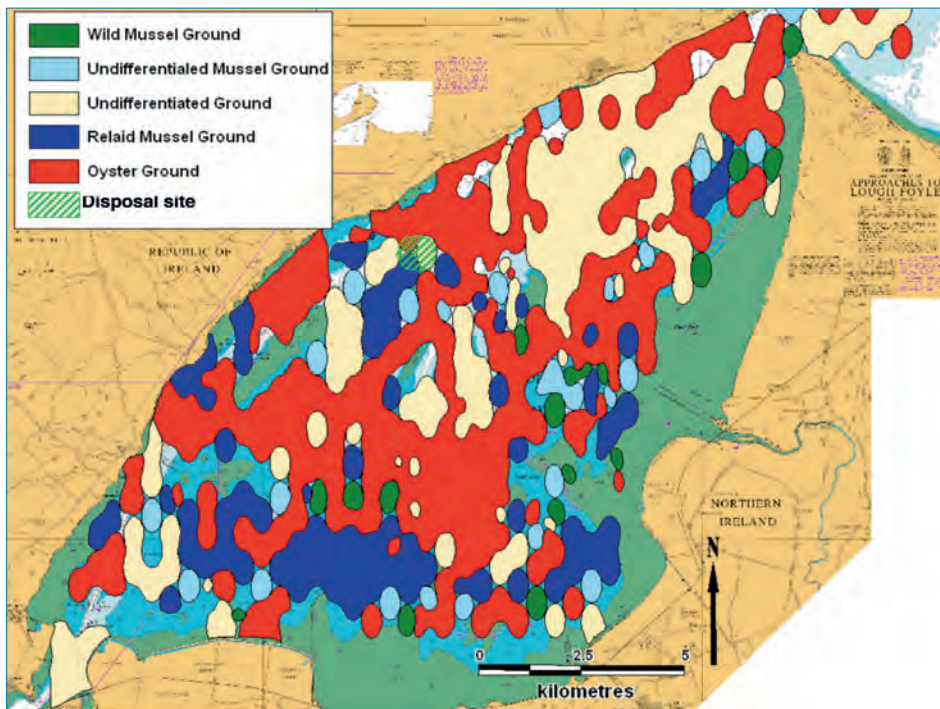


Figure 9. Shellfish Resource in Lough Foyle (adapted from CEFAS, 2007).

improvements with respect to potential adverse effects on the settlement of oyster larvae compared to the use of the Redcastle site.

Mussels

Impacts of the dredging plume from the McKinney's Bank disposal site on mussel beds in Lough Foyle are considered negligible. Mussels are known to be very tolerant of extremely high

turbidities. Although incidental excess turbidities over 100 mg/l do occur in the vicinity of the McKinney's Bank disposal site, excess turbidity never exceeds 10 mg/l for more than 5% of the time (over a 14 day spring-neap tidal cycle) except in an area limited to the McKinney's Bank disposal site. This will not have any impact on mussels (adults, larvae or spat). Sedimentation nowhere reaches lethal levels for mussels.

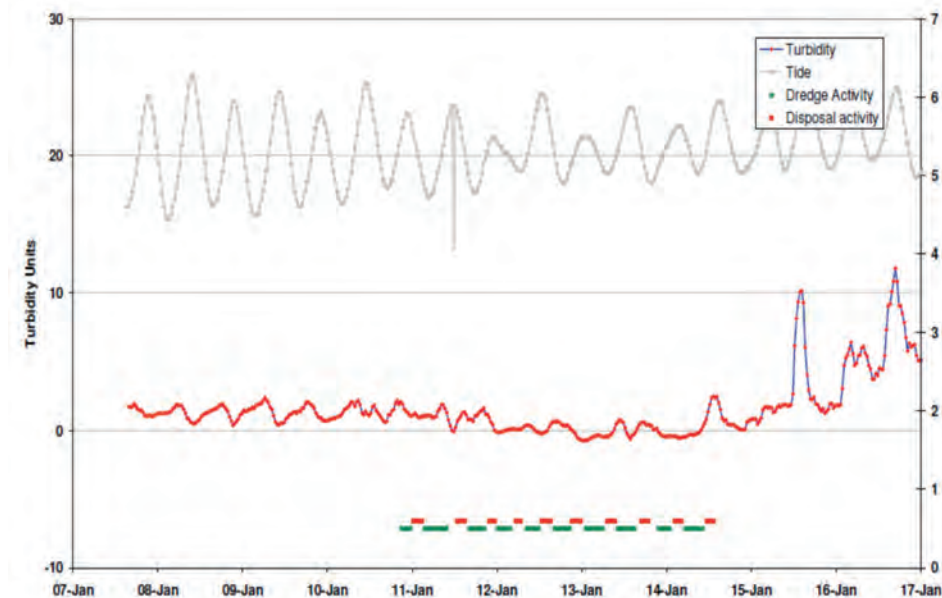


Figure 10. Turbidity and Local Tide at the Glenburnie Light Monitoring Station (AFBI, 2011).

Disposal at McKinney's Bank

Clearly sedimentation and, therefore, impacts throughout the Lough are significantly lower if the alternative McKinney's Bank disposal site is used rather than the existing Redcastle disposal site.

LICENSING

Following the encouraging predictions of the modelling in relation to the published knowledge concerning shellfish response, application was made for a licence to dispose of 60,000t annually at the McKinney's Bank disposal site.

As is standard procedure, the application was subject to widespread consultation. No objections were received that were judged by NIEA to be of sufficient concern to justify refusal. However, as a precautionary measure, it was agreed that prior to the issue of a licence a programme of monitoring should be agreed between the Port, NEIA and the Loughs Agency. The agreed monitoring programme specified that turbidity levels be continuously monitored at a fixed station for a period commencing one month prior to the commencement of dredging and for three months thereafter. The location finally agreed for monitoring was: Glenburnie Light at 55° 10.41'N, 007° 1.56'W.

It was further agreed that 20 bed samples be collected on a grid basis from three locations (approximately seven per site). The sampling sites selected were those identified by the modelling process as the potential areas of highest deposition. The analysis of these samples was to determine if the particle distribution in the selected areas had been changed significantly during the initial six months of dredging and disposal.

In October 2010 a formal application was therefore made for the disposal of 60,000t annually at the McKinney's site. Following a tendering procedure, a contract for monitoring was awarded to the Fisheries & Aquatic Ecosystems Branch of the Northern Ireland Agri-Food & Bioscience Institute (AFBI) for the provision, installation and operation of a fixed instrument. This was a fixed continuous turbidity monitor of the type "Hydrolab MiniSonde MS5". The instrument was installed on 02 December 2010 to measure the following parameters: temperature; luminescent conductivity; and luminescent dissolved oxygen.

Turbidity data (smoothed, 3h rolling average) in Lough Foyle normalised across sites

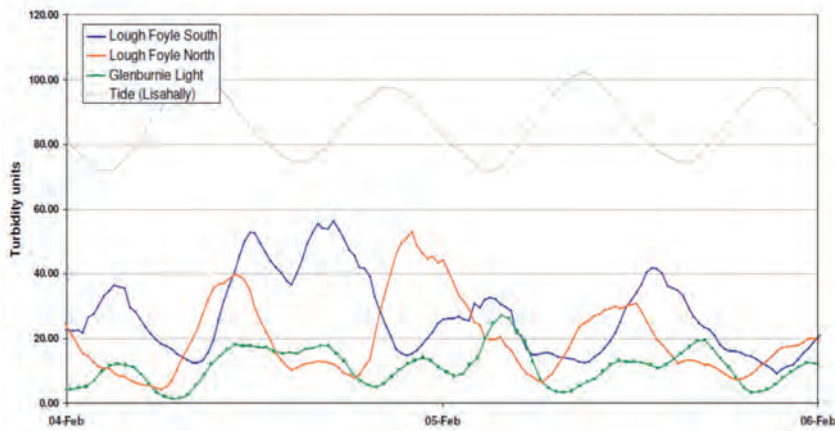


Figure 11. Turbidity (measured by optical backscatter) and Local Tide Height (above instrument) at Monitoring Stations within Lough Foyle. (All turbidity data have been normalised to a certified reference instrument for optimum comparability, and smoothed using a 3-hour rolling average.)

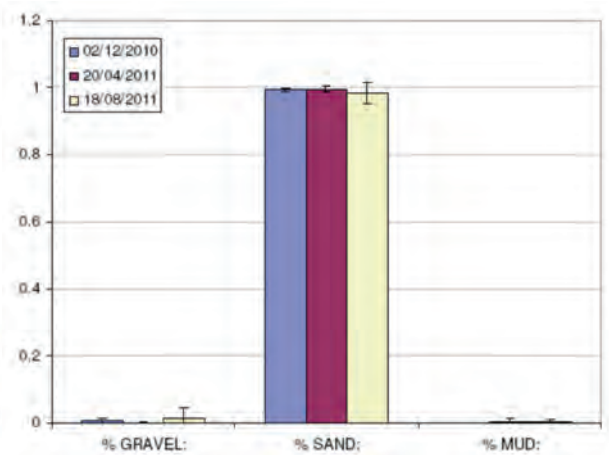


Figure 13. Results of 'Before' and 'After' Sediment Sampling and Testing at Site 1.

Upon installation of this instrument and the initial bed sampling NIEA granted a licence for the period 01 January to 31 December 2011 for 60,000 tonnes. Dredging and disposal operations by the Port dredger commenced on 11 January 2011. On 07 January 2011 the instrument was attended to download the collected data, but unfortunately it was found that the instrument attached to the Glenburnie Light had malfunctioned – a failure of the wiping mechanism caused an interference with the optical turbidity measurement. As a result, the data collected was not deemed reliable.

Fortunately, as a result of the extensive monitoring stations in the Lough, it was possible to interpolate between data sets routinely collected by AFBI at other locations within the Lough and mathematically deduce a substitute data set sufficient for the purpose of monitoring the effect of dredging and disposal.

Data from 07 January to 17 February 2011 was downloaded twice to minimise the risk of further failures – once on 11 January 2011 and again on 17 February 2011. No further malfunction of the instrument was noted.

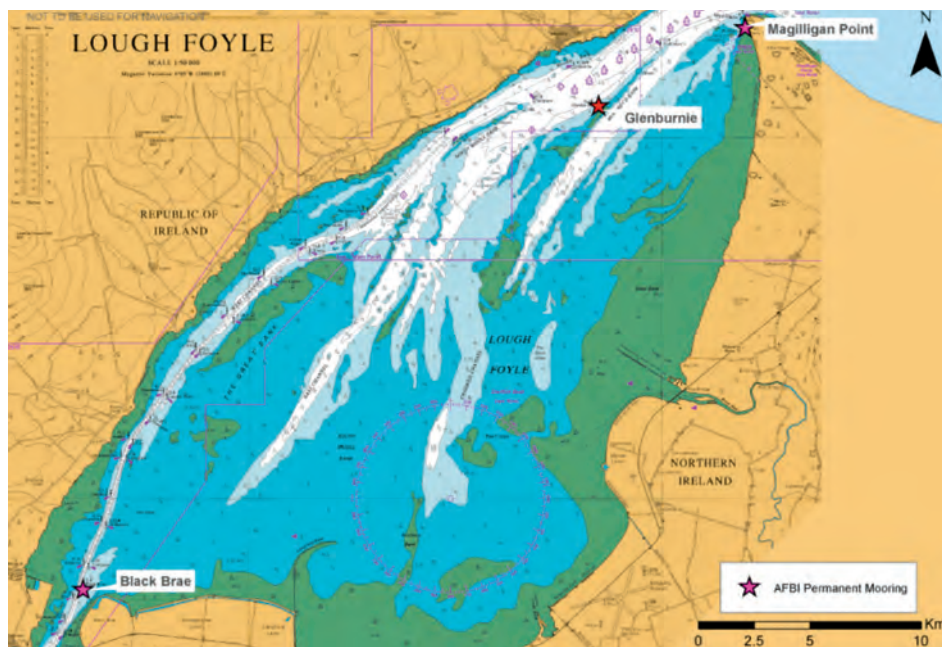


Figure 12. Locations of AFBI's Permanent Lough Foyle Monitoring Stations.

Figure 11 presents the results recorded at that time (AFBI, 2011). The data indicates that tidal flow, as well as spring and neap cycles, are the dominant influence on the patterns of turbidity. Disposal activities at McKinney's Bank disposal site have occurred on neap tides but have not caused any notable increase in turbidity levels.

To understand the effect of the dredging and disposal activity on turbidity levels the records obtained from the Glenburnie Light site (see Figure 10) were compared with contemporary records from two regular monitoring sites elsewhere within the Lough known as Lough Foyle North and South (see Figure 11). The results for all three sites are provided in Figure 13. The results of the second testing of seabed sediments at three sites were also favourable. The location of the three sites from which samples were taken is shown approximately in Figure 7.

The AFBI report (2012) provides the results of the sediment analysis and those results for Area 1 are provided in Figure 13. The results of testing at the other two sites also record no significant change in the characteristics of the seabed sediments. In fact, the AFBI report states that, "The three monitoring areas displayed statistically different sediment characteristics with subtle differences in the amount of fine material entrained within the samples. The differences were however consistent and stable; no statistical difference in the sediment composition or structure was detected over time".

CONCLUSIONS

These conclusions regarding the effect of dredging and disposal are based on reports by AFBI on the results of monitoring of turbidity levels and other effects at Glenburnie Light in Lough Foyle. Glenburnie Light was chosen as a monitoring point as it is considered to be a convenient location at which the effect of dredging and disposal, if any, could be observed. The objective of the monitoring of turbidity levels at the Glenburnie Light was to determine whether or not the disposal of sediments during routine maintenance dredging activity causes any significant increase in turbidity relative to the ambient conditions in areas of the Lough that are remote from the dredging. The conclusion was that it does not, as is clear from examination of the recorded results that are illustrated in Figure 12.

The AFBI report states, *“The combination of instrumental water quality monitoring and sediment analysis did not identify any significant transport (in the water column) or deposition of sediment in the monitored areas during or for the three months after the dredge disposal activity.”*

It is apparent that the state of the tide is the predominant influence on sediment suspension and, furthermore, it is also clear that the level of suspension caused by tidal flow, particularly mid-flood and mid-ebb flow, is much greater than the effect of the disposal of dredged material. Occasional high terrestrial fluvial flows were also shown to result in raised levels of suspended sediments.

No correlation between dredging, disposal and turbidity levels has been identified. However,

whereas the records of disposal available to AFBI are comprehensive, the records of dredging are not and hence it has not been possible to attempt any meaningful correlation between the act of dredging and turbidity levels. On the basis of the limited dredging activity data that has been examined, AFBI opine that there may be a weak but detectable affect. However, it is apparent that any affect is small in relation to the much stronger effects coming from the natural forces of tidal flow and wind generated waves over the many shallow areas of the Lough.

Other causes of sediment suspension, such as high fluvial flows, the navigation of deep draught vessels and the action of trawling when harvesting shellfish, can also be expected to have significant localised effects. Of these, from unrecorded observations, it will not be surprising if trawling has the greatest effect, but as this has not been measured, it is not certain.

The results of monitoring seabed sediments at three potential sediment receptor sites do not record any significant effect caused by the dredging and disposal activities. The AFBI report states that, *“There has been no statistically detectable change in the sediment composition or structure at the three monitoring areas over time. The sediments from all three areas were characterised the same at the beginning, middle and end of the monitoring period. No significant changes in any of the sediment fractions were detected indicating that there had been no deposition of fresh material resulting from the dredge disposal.”*

In summary, the monitoring programme has demonstrated that the changed regime of regular small-scale dredging and disposal of all dredged sediments at the new McKinney's Bank

disposal site has no significant detectable effect on water quality or seabed sediment characteristics within the Lough, other than within the immediate environs of the licence area.

The clear benefits of disposal of dredged material within the Lough include:

- the retention of sediment within the Lough;
- a large reduction in the carbon footprint of the disposal activity;
- reduced dredging cost, and
- the opportunity for maintenance dredging to be carried out by the port using local labour with consequent benefit to the local economy.

In all probability there is also a benefit to fisheries as a result of the modest, but regular reworking of the seabed sediments in areas of dredging and disposal with consequent increase in the availability of nutrients for shellfish and mobile species. This begs the question, why in the past have local fishing interests been so intransigent in resisting change when science has predicted no significant adverse effect?

The result of this unfounded attitude has been excessive cost and energy consumption, particularly associated with the channel deepening in 1993, when objections from fisheries interests resulted in all dredged material being disposed of outside of the Lough at a site so distant from the area of dredging as to be closer to Scotland than to Ireland. This situation persisted for maintenance dredging until the issue of the new licence in January 2011. Hopefully, henceforth, a more balanced approach that recognises the wider interests, not only of fisheries, but also of the environment, the local community and commerce will prevail.

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