Attachment D.1

Assessment of Impact on the Receiving Environment

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IMPACT ASSESSMENT STUDIES:

Shannon Foynes Port Company employed Aqua Fact Limited, in Galway, to carry out three Environmental Assessment and Sediment Transport Modelling for the three Approved Dump Sites used for the disposal of dredged spoil.

The first was in 2003 and assessed two dump Sites in the upper Estuary at Newtown Point and Coonagh Point. The Dump Site at Coonagh Point was later decommissioned as a result of the construction of the Tunnel Crossing at this point.

The second assessment undertaken also in 2003 was for the Dump Site off Foynes Island.

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The third assessment was carried out in 2005 at a Dump Site South of Sod Island, this was as a result of decommissioning the Dump Site at Coonagh Point.

Sediment transport analysis and modelling was undertaken for all three sites and the results indicated that all three were suitable for the disposal of dredge material, with careful management of the dumping operation.

The three reports are contained below and are labelled Sections 1,2 and 3.

There were Archaeological surveys undertaken for all three sites also and the results of these are contained in Sections 4, 5 and 6 below.

An Appropriate Assessment for Natura 2000 Site was also carried out by RPS and this is contained in Section 7 below.

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SECTION 1

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IMPACT ASSESSMENT STUDY OF TWO DREDGE DISPOSAL SITES IN THE SHANNON ESTUARY.

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For: Shannon Foynes Port Company,
Mill House,
Foynes,
Co. Limerick.

By: Aqua-Fact International Services Ltd.,
12 Kilkerrin Park,
Liosbaun,
Galway.
www.aquafact.ie

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CHAPTER 1
INTRODUCTION

Aqua-Fact International Services Ltd. were commissioned by Shannon-Foynes Port Company to carry out an impact assessment study of the environmental effects caused by maintenance dredging in the Shannon Estuary and subsequent disposal of the dredged material within the estuary at two proposed sites. Maintenance dredging is carried out to maintain the natural chart datum within the estuary as published on British Admiralty Charts for the area.

The purpose of the study was to model the transport and deposition of the disposed material in order to assess its impacts on water quality and the sea bed in the area surrounding the disposal sites. This was achieved with the use of the U.S. Army Corps of Engineers' Open Water Disposal Model (STFATE), which accounts for the physical processes determining the short-term fate of the dredged material disposed at open water sites. The model provides estimates of water column concentrations of suspended sediment and the initial deposition of material on the sea bed.

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A description of the location and bathymetry of each of the disposal sites is presented in Chapter 2. All the relevant environmental and hydrodynamic data required as input to the model are also described in Chapter 2. The theory, development and application of the model to analyse the short-term fate of the disposed material at each of the dump sites is detailed in Chapter 3. Chapter 4 and Chapter 5, respectively, present and discuss the results obtained from the model simulations. Finally, in Chapter 6, the summary and conclusions of the project are presented and some recommendations are provided based on the study's conclusions.

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CHAPTER 2
MODEL DATA INPUT

2.1 Disposal Sites

This report deals with inner area of the Shannon Estuary located between Limerick and Shannon Airport Jetty. Table 2.1 details the extent of the dredging operations that are expected to be required in order to maintain Chart Datum at this site (Shannon-Foynes Port Company, 1999).

Location	Material	Quantity
Limerick Dock	Mud/Silt	150,000 m^3

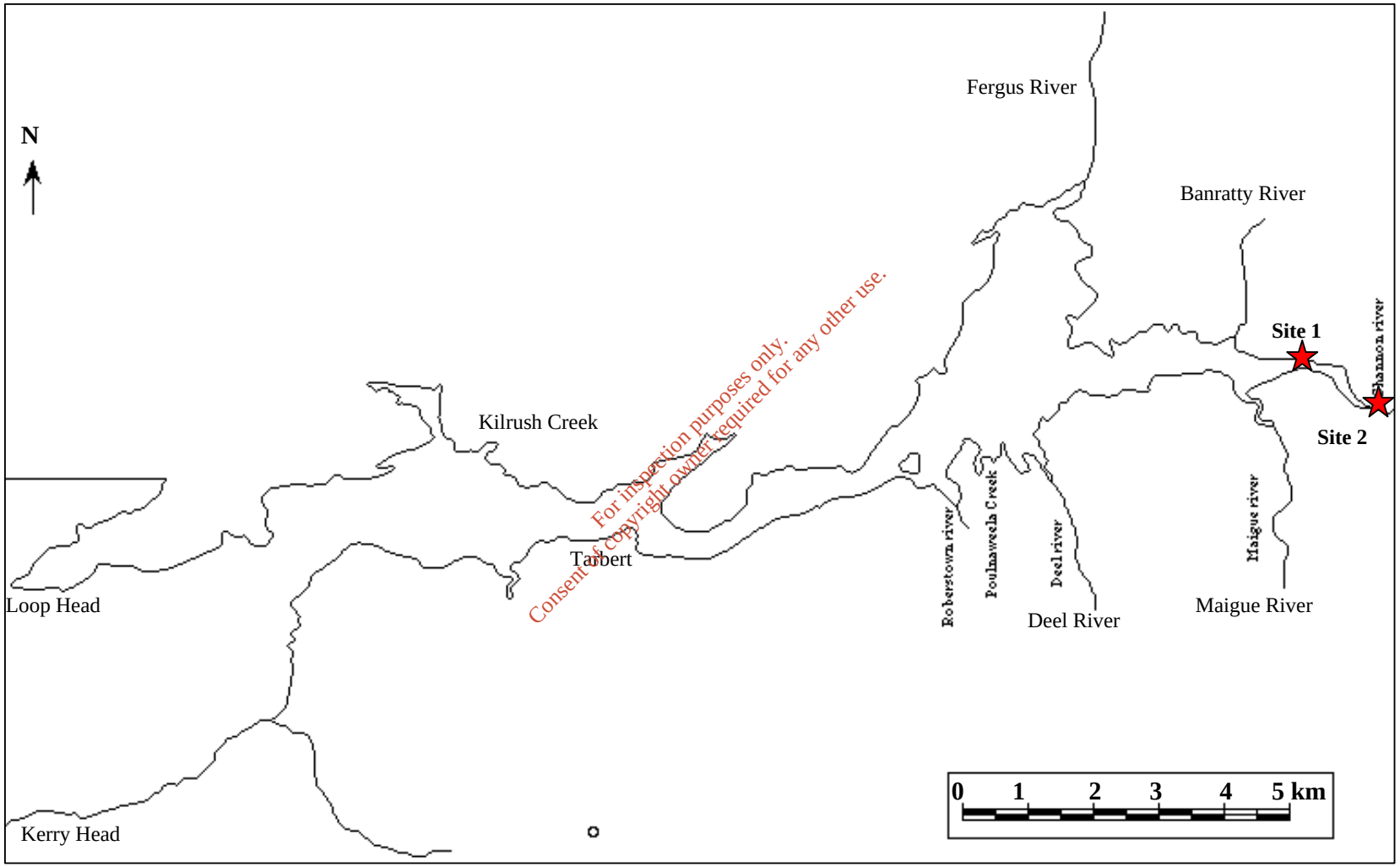
Table 2.1: *Details of proposed dredging operation.*

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It is proposed that the dredged material will be dumped at two disposal sites, the locations of which are shown in Figure 2.1. Their coordinates are as follows:

- **Site 1:** Near Newtown Point – (52° 40’ 26.4’’ N, 8° 44’ 19.2’’ W)
- **Site 2:** Near Coonagh Point – (52° 39’ 13.2’’ N, 8° 41’ 10.2’’ W)

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Figure 2.1: *Plan view of the Shannon Estuary showing the locations of the two proposed Dump Sites.*

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The bathymetric profiles at each of the sites as taken from the respective Admiralty Charts are shown in Figures 2.2 – 2.3. In each case, the boundary of the dump site is highlighted in red.

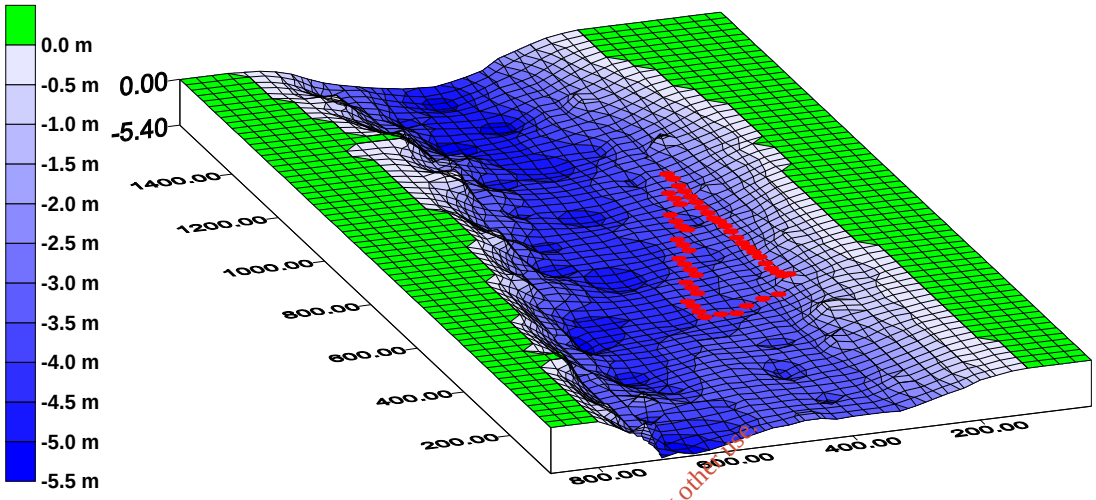


Figure 2.2: *Study area incorporating Dump Site 1, depths in metres below MWL.*

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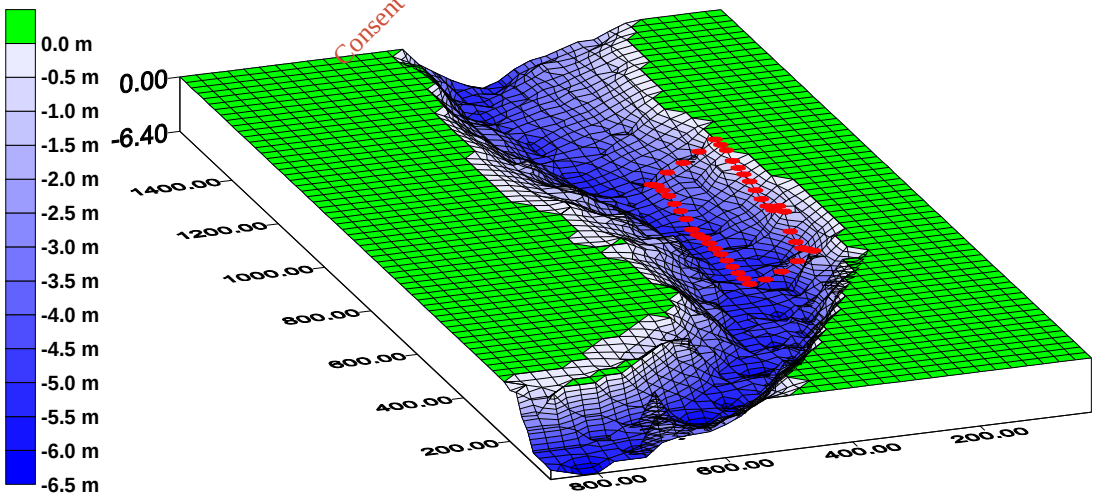


Figure 2.3: *Study area incorporating Dump Site 2, depths in metres below MWL.*

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The STFATE model can only be run using a flat bed surface or one with a constant slope. Therefore, an average water depth was calculated for the extent of each of the study areas shown in the diagrams above for use in the model simulations.

2.2 Hydrodynamic Data

In studies investigating the impact of the disposal of dredged material there are two important considerations to take into account:

a) Whether the dredged material will be transported outside the boundary of the disposal site by the prevailing currents, which is most likely to occur when the currents are at a maximum.
b) Whether the build-up of dredged material on the sea bottom will significantly reduce the depth of water at the disposal site, which is most likely to occur when the currents are at a minimum.

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With these considerations in mind, it was decided to analyse the disposal of the dredged material using two different hydrodynamic regimes, namely the maximum current velocity and minimum current velocity at each of the sites.

The current velocity data at each of the dump sites were obtained from the Shannon Estuary Hydrodynamic Model which is already in existence and is owned by Shannon-Foynes Port Company. The model was executed and the current velocities and directions were computed and output at each of the proposed dump site locations for both spring and neap tidal conditions. From these plots of current velocity the maximum, average and minimum velocities were then calculated. The current data for spring tidal conditions were used in the model as current velocities reach their maximum during a spring tide. All of the current data input to the STFATE model are presented in Table 2.2.

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Analysis	Description	Current Speed (m/s)	Current Direction (degrees from N)
1	Maximum Velocity - Site 1	0.700	91.390
2	Minimum Velocity - Site 1	0.020	29.600
3	Maximum Velocity - Site 2	0.280	92.890
4	Minimum Velocity - Site 2	0.009	179.375

Table 2.2: *Current data used in STFATE model simulations.*

2.3 Dredged Material Data

The Environmental Services section of Enterprise Ireland analysed sediment samples taken from the approach to Limerick Dock on the 28th June, 2002 and at the 'Wet Dock' on 17th October, 2002. The reports from both sediment studies show that the dredged material is composed predominantly of a mixture of sand and silt. However, the 'Wet Dock' area also contains relatively high proportions of gravel material (~20-30%). The properties of the material as specified to the model are presented in Table 2.3.

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Type	Spec. Gravity [mg/m^3]	Volumetric Conc.	Fall Vel. [m/s]	Deposited Void Ratio	Character
Sand	2.70	0.1918	3.05×10^{-2}	0.6	Noncohesive
Silt	2.65	0.3265	3.05×10^{-3}	4.5	Cohesive

Table 2.3: *Properties of dredged material input to model.*

The data on the properties of the dredged material used for the model refers to a site investigation carried out in the Shannon Estuary by The Environmental Services section of Enterprise Ireland in 1998 (Report ref.: 98078). From this report the material to be dredged consists of a mixture of sand and silt and does not include fractions of coarser gravel material (>2mm), such as that recorded from the 'Wet Dock' in 2002. In comparison to fine sediments coarser material such as gravel will not be transported away from the dump site to the same extent or be re-suspended once it settles on the bottom.

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2.4 Disposal Operation Data

The disposal of dredged material will take place from a grab dredger with bottom opening doors for disposal. Although the dumping operation is considered to be instantaneous, it is assumed that the time to completely empty the dredging vessel will be approximately 3 ½ minutes. The input data specified to the model regarding the disposal operation are presented in Table 2.4 (Shannon-Foynes Port Company, 2000).

Disposal Operation Detail	Value Input to Model
Mass of dredged material held in vessel	450 tonnes
Vessel length and width	43.6 x 9.9 m
Pre-disposal draft of vessel	3.2 m
Post-disposal draft of vessel	2.9 m
Angle of discharge	vertical
Time to empty vessel	210 s
Vessel velocity	stopped

Table 2.4: *Details of dredging operation data input to the model.*

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CHAPTER 3
MODEL THEORY AND DEVELOPMENT

3.1 Introduction

The objective of this study is to determine the impacts on the water column and the sea bed of the disposal of dredged material at each of the proposed dump sites. The initial phase of deposition of dredged material follows immediately upon release from the disposal vessel. Accurate representation of the initial mixing process of the dredged material is required to determine estimates of water column concentrations of suspended sediment and the initial deposition of the material on the bottom. In order to accurately represent the physics of the disposal, the mathematical model STFATE was employed to determine the characteristics of the initial mixing phase.

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3.2 Theory

In the STFATE model, the behaviour of the material is assumed to be separated into three phases: **1) *convective descent***, during which the dump cloud or discharge jet falls under the influence of gravity and the initial momentum of the discharge; **2) *dynamic collapse***, occurring when the descending cloud or jet impacts the bottom or arrives at a level of neutral buoyancy where descent is retarded and horizontal spreading dominates; **3) *passive transport-diffusion***, commencing when the material transport and spreading are determined more by ambient currents and turbulence than by the dynamics of the disposal operation (U.S. EPA & U.S. Army Corps of Engineers, 1995). Figure 3.1 illustrates these three phases of material behaviour. The passive transport and diffusion phase in the model is handled by allowing the material settling from the descent and collapse phases to be stored in small Gaussian clouds. These clouds are then diffused and transported at the end of each time step.

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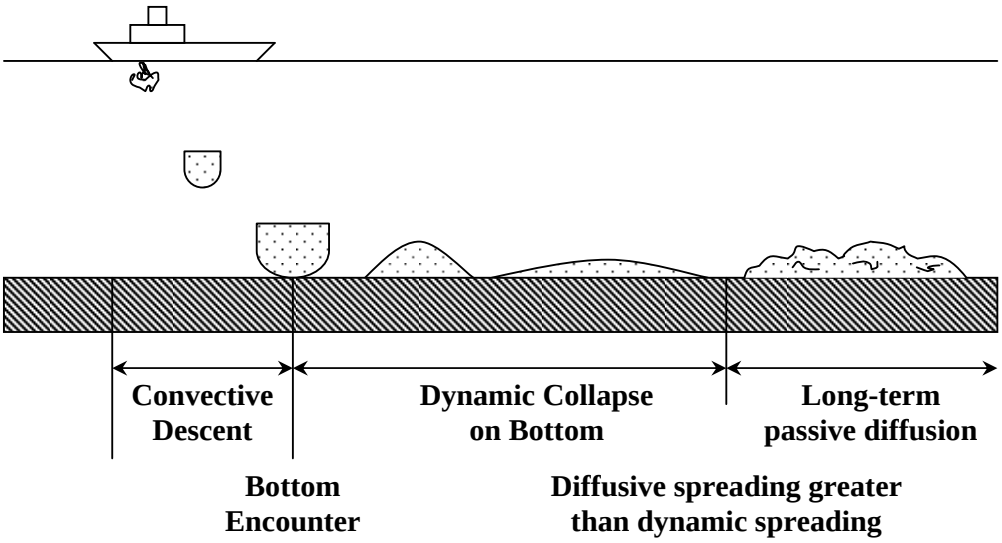


Figure 3.1: *The three stages of material behaviour as assumed in STFATE model (U.S. EPA & US Army Corps of Engineers 1995).*

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3.3 STFATE Model Development

The study areas were declared to the model in the form of a rectangular grid of equal cell spacings. Each grid cell was then assigned the average depth that had been calculated for the associated study area. Table 3.1 gives the grid sizes and spacings and the average depth used to simulate each of the dump site study areas. It should be noted that the average depths used in the models were calculated using water depths at mean water level.

Dump Site	Grid Area [km^2]	Grid Spacing [m]	No. of Rows	No. of Columns	Depth [m]
Site 1	0.75 x 0.75	100	30	30	2.88
Site 2	0.75 x 0.75	100	30	30	3.16

Table 3.1: *Grid sizes, spacings and depths used in model simulations.*

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3.4 STFATE Model Analyses

A total of four model simulations, two for each dump site, were performed using the STFATE model in order to predict the initial deposition of dredged material resulting from a single disposal operation under two different current velocity conditions. The simulation times varied between 1 hour and 2 hours for the model runs depending on model output constraints. However, in all cases the times were of sufficient duration to allow the majority of the dredged material to settle to the bed surface and, hence, determine the maximum thickness of the deposited material. The execution timestep used during the model runs for the long-term transport-dispersion calculations was 100 seconds, which is the minimum timestep allowable in the model. The two STFATE analyses at each site for the two different velocity conditions were described in Chapter 2 and are reproduced in Table 3.2.

Analysis	Description	Current Speed (m/s)	Current Direction (degrees from N)
1	Maximum Velocity - Site 1	0.700	91.390
2	Minimum Velocity - Site 1	0.020	29.60
3	Maximum Velocity - Site 2	0.280	92.890
4	Minimum Velocity - Site 2	0.009	179.375

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Table 3.2: *Current data used in STFATE model simulations.*

In each case the current velocities were assumed to be uniform over the entire water depth and were input to the model as depth averaged velocities. The velocities and directions were also assumed to be constant over the whole of the study area and for the full duration of the simulations.

The model was unable to simulate the required disposal scenarios. This was due to the volume of material to be dumped during each operation being too large compared to the shallow water depths in the vicinity of the disposal sites. However, following experimentation, it was found that when hydrodynamic conditions were kept constant an approximate linear relationship could be developed relating the volume of dredge material to be dumped to the predicted maximum thickness of deposited material on the estuary bed following a disposal operation. This relationship was then used to

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calculate the predicted maximum thickness of deposited material following the disposal of the correct volume of dredge material.

3.5 STFATE Model Results

Results from the STFATE model may be presented using the following five formats:

1) Graphs showing the development of the plume and its extent during the convective descent and cloud collapse phases.
2) Graphs showing the extent and movement of the plume of suspended material during the long-term transport-dispersion phase.
3) Graphs of suspended solids concentrations within the water column over the period of simulation.
4) Concentration contours of each material solid fraction at various depths and times chosen by the user.
5) Three dimensional deposition plots of material on the sea bed at the end of the simulation period.

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Formats 2-5 are produced for each of the solid fractions simulated, which in the case of this study were sand and silt. Therefore, for each of these result formats there are two sets of results for a single simulation.

Since the model could not simulate the required scenarios, the only results presented are the graphs showing the linear relationships developed for the volume of dredge material and the maximum thickness of the resulting deposited layer.

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CHAPTER 4
MODEL RESULTS AND DISCUSSION

In this chapter, the results of the STFATE model simulations for the two different hydrodynamic regimes are presented and discussed. Results are presented for each of the three physical processes represented in the model and described in Chapter 3 (convective descent, cloud collapse and long-term transport-diffusion). A discussion of these results is presented in Chapter 5 while conclusions drawn from them are presented in Chapter 6.

4.1 Dump Site 1 – Near Newtown Point

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The average water depth calculated for Dump Site 1 at mean water level was 2.88 m. However, the pre-disposal draft of the disposal vessel when fully loaded is approximately 3.2 m. Because of this, an analysis of the disposal of dredged material was carried out at Dump Site 1 during spring high tide conditions only.

As described in Chapter 3, it was discovered from the results of numerous model simulations that under constant hydrodynamic conditions, an approximate linear relationship existed between the volume of dredge material being dumped and the maximum thickness of the resulting layer of deposited material. Therefore, for Analyses 1, the maximum velocity condition at Dump Site 1, and Analyse 2, the minimum velocity condition at Dump Site 1, a number of simulations were executed using different volumes of dredge material ranging from 19 m^3 to the maximum volume allowed by the model constraints. A 'material volume versus deposited layer thickness' relationship was then developed for each analysis based on the results of these simulations and a prediction of the maximum thickness of the deposited layer resulting from the disposal of the correct volume of material was then calculated.

Figure 4.1 shows the relationship between the volume of dredge material and the maximum thickness of the resulting deposited layer obtained for maximum current velocity conditions at Site 1. As can be seen, the regression coefficient for the linear

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approximation of the model results has a value of 0.9955 indicating that the relationship is almost exactly a linear one. Using the relationship shown on the graph, a maximum thickness of deposited material of approximately 44.7 mm was calculated for the actual volume of dredge material, 293.6 m^3, to be dumped at the site. The calculation is as follows:

Maximum thickness = 0.1551(Volume of material) - 0.7922

$\Rightarrow$ Maximum Thickness = 0.1551(293.6) – 0.7922)

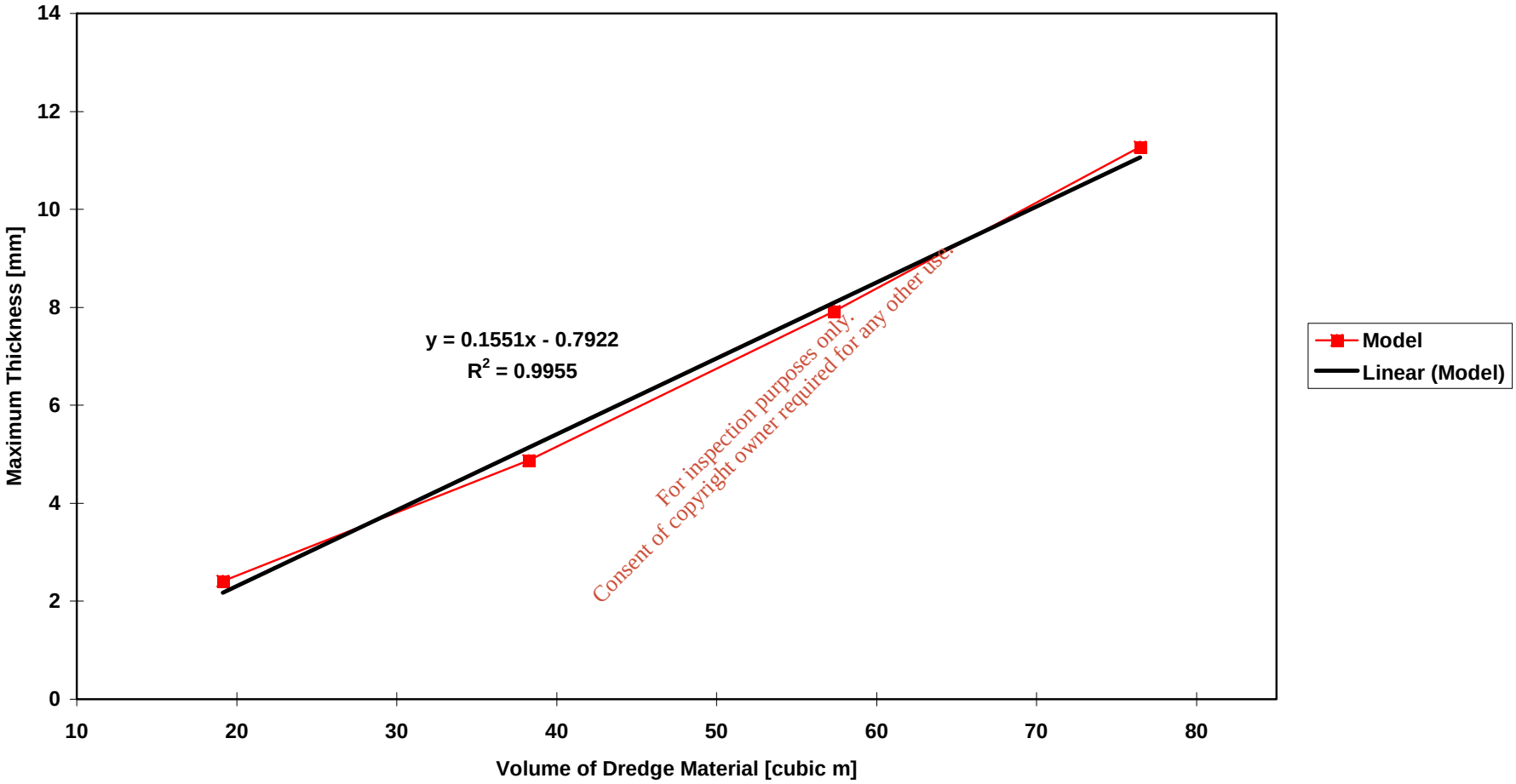
$\Rightarrow$ Maximum Thickness = 44.7 mm

Figure 4.2 shows the relationship between the volume of dredge material and the maximum thickness of the resulting deposited layer obtained for minimum current velocity conditions at Site 1. As can be seen, the regression coefficient for the linear approximation of the model results has a value of 0.9998 indicating, as before, that the relationship is almost exactly a linear one. Using the relationship shown on the graph (y = 0.2104x - 0.4266) a maximum thickness of deposited material of approximately 61.3 mm was calculated for the actual volume of dredge material, 293.6 m^3, to be dumped at the site.

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It should be noted that in both cases the maximum layer thicknesses will occur within the grid cell directly below the point of discharge and will cover the entire grid square.

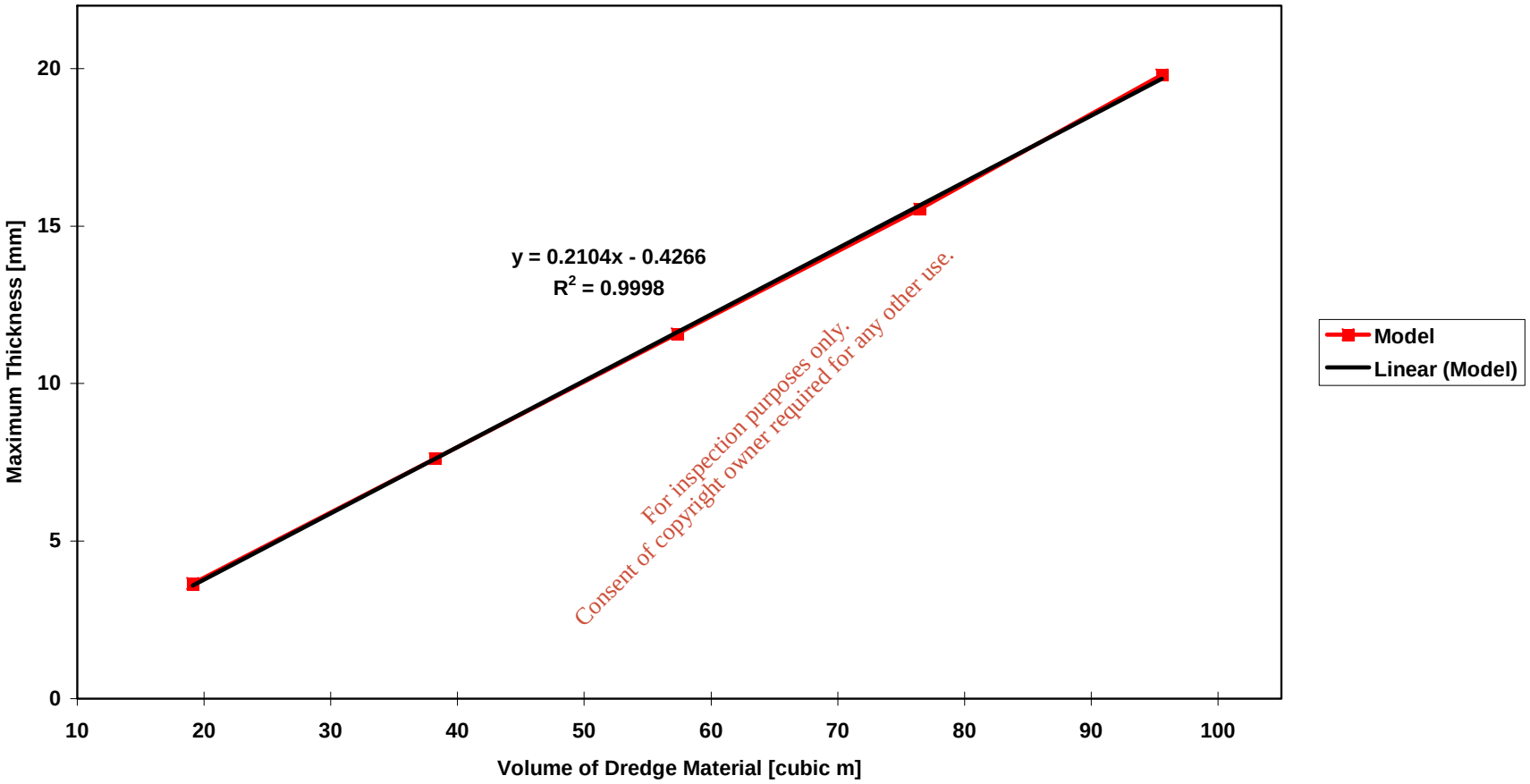
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Figure 4.1: *Relationship between volume of dredged material and maximum deposited layer thickness for Analysis 1.*

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Figure 4.2: *Relationship between volume of dredged material and maximum deposited layer thickness for Analysis 2.*

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4.2 Dump Site 2 – Near Coonagh Point

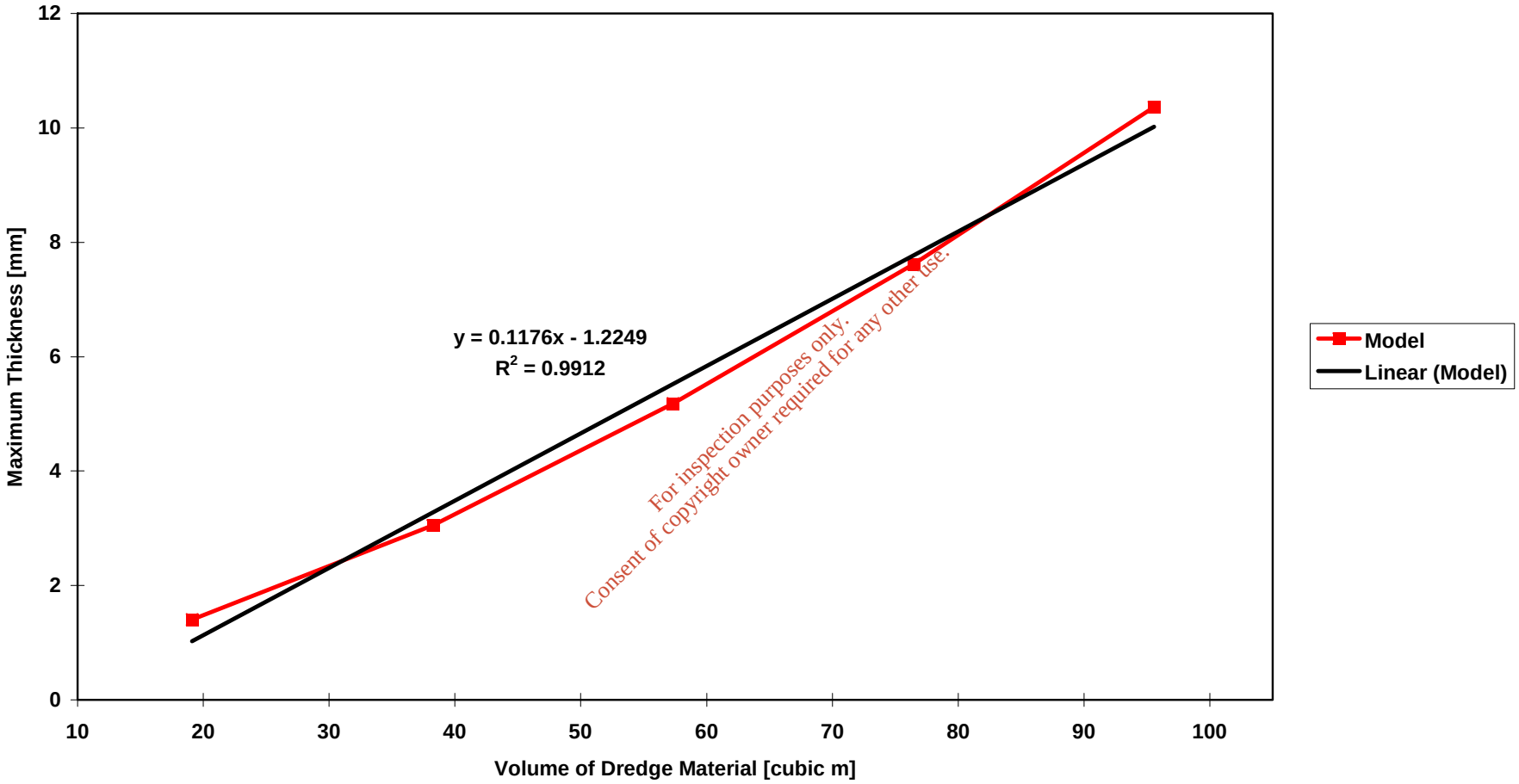
The average water depth calculated for Dump Site 2 at mean water level was 3.16 m. However, as stated previously, the pre-disposal draft of the disposal vessel when fully loaded is approximately 3.2 m. Therefore, as for Dump Site 1, an analysis of the disposal of dredged material was carried out at Dump Site 2 during spring high tide conditions only.

A number of simulations were executed for Analyses 3, the maximum velocity condition at Dump Site 2, and Analyse 4, the minimum velocity condition at Dump Site 2, using different volumes of dredge material ranging from 19 m^3 to the maximum volume allowed by the model constraints. The 'material volume versus deposited layer thickness' relationships were then developed for both hydrodynamic conditions based on the results of these simulations allowing the calculation of the predicted maximum thickness of the deposited layer resulting from the disposal of the correct volume of material.

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Figure 4.3 and Figure 4.4 show the relationship between the volume of dredge material and the maximum thickness of the resulting deposited layer obtained for maximum and minimum current velocity conditions at Site 2, respectively. As can be seen, the regression coefficient for the linear approximation of the model results has a value of 0.9912 for Analysis 3 indicating that the relationship is almost exactly linear and a value of 1 for Analysis 4 indicating a perfect linear relationship. Using the relationship shown on the graph for Analysis 3 (y = 0.1176x - 1.2249), a maximum thickness of deposited material of approximately 33.3 mm was calculated for the actual volume of dredge material, 293.6 m^3, to be dumped at the site, while using that shown for Analysis 4 (y = 0.2072x - 0.3047), a maximum thickness of 60.5 mm was calculated. The maximum thicknesses will occur within the grid cell directly below the dredge vessel and will cover the entire cell.

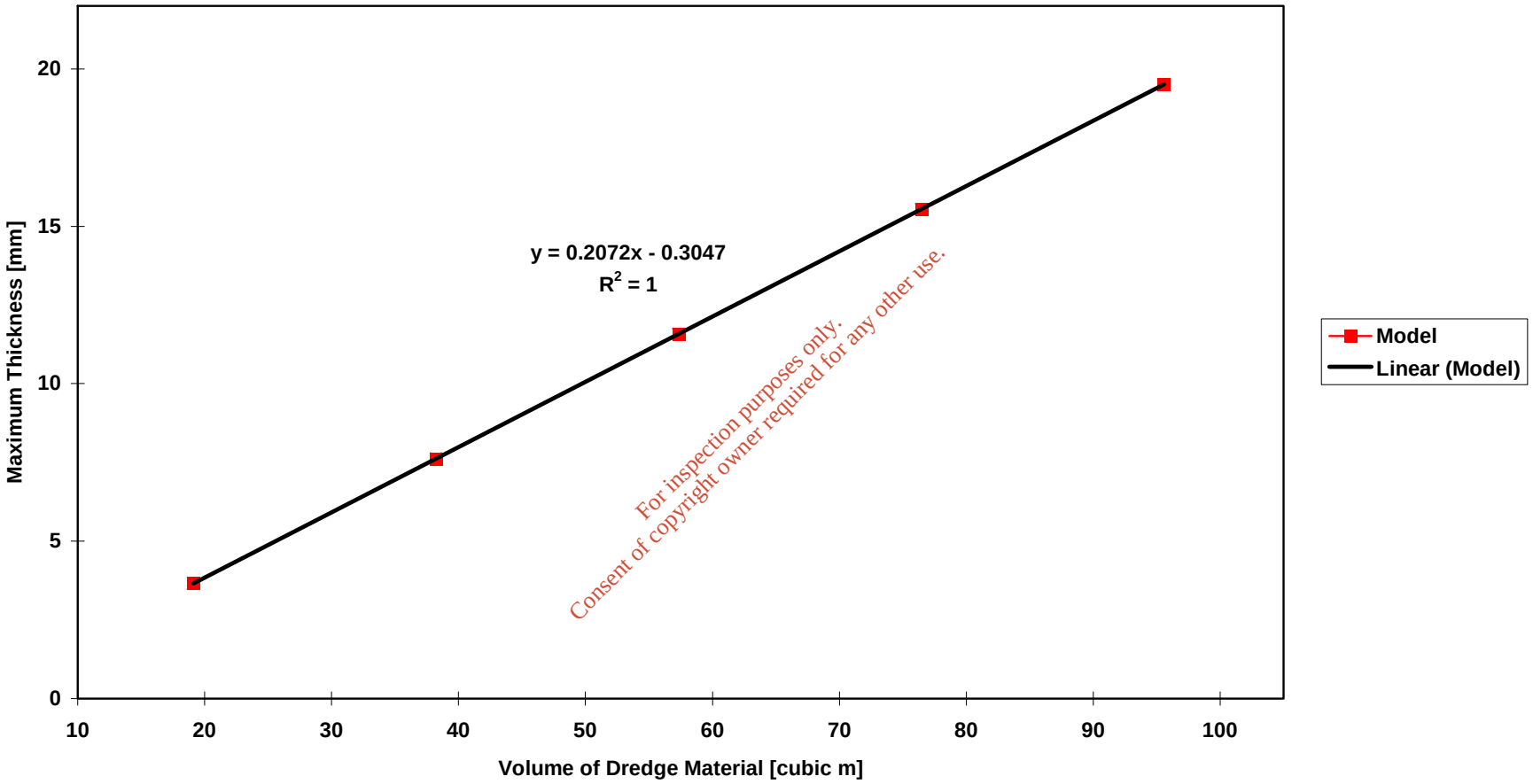
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Figure 4.3: *Relationship between volume of dredged material and maximum deposited layer thickness for Analysis 3.*

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Figure 4.4: *Relationship between volume of dredged material and maximum deposited layer thickness for Analysis 4.*

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CHAPTER 5
DISCUSSION OF RESULTS

The results of the model simulations carried out for the two proposed dump sites are discussed in this chapter. The results were analysed in such a way as to ascertain the possible impacts of the disposal of dredge material on water quality and the sea bed in the area surrounding the disposal sites. The following sections deal with the effects of water depths and current velocities on the transport and deposition of dredge material following its disposal, the comparison of model results between the disposal sites, and the ecological impacts of the disposal of dredge material within the Shannon Estuary.

5.1 Effects of Water Depths

The greater depth of water allows a greater proportion of material to be transported away from the dump site resulting in a reduction in deposited layer thickness close to the site. Therefore, the deeper the depth of water at the disposal site, the smaller the localised accumulations of dredged material. This fact is highlighted by the large increases in the maximum deposited layer thickness calculated at both sites due to the shallowness of the areas.

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5.2 Effects of Current Velocities

In general, it would be expected that the peak thicknesses recorded during a single dumping operation carried out under maximum current velocity conditions, would all be lower than the maximum thicknesses recorded under minimum velocity conditions at the same sites. This is due to the fact that a greater proportion of material is transported away from the dump site prior to reaching the bed surface as a result of the stronger currents. The stronger currents, make for a more even distribution of settled dredged material on the bed surface. Although the plume of suspended material does travel much further from the dump site at maximum current speeds than at the lower current speeds, the vast majority of the material settles to the bed within

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the immediate vicinity of the dump site and the remaining suspended material will, therefore, have a negligible impact on the water depth when it does eventually settle. This would suggest that the optimum time for disposal of the dredged material is at the time of maximum current speeds at each of the dump sites.

5.3 Comparison of Sites

From the results provided for Dump Sites 1 and 2, located downstream of Limerick Docks at Newtown Pt. and Coonagh Pt. respectively, it is apparent that while both of these proposed disposal sites are suitable for the dumping of dredged material, due to the shallow depth of water at the sites and the relatively slow ambient current speeds, the volume of material which may be dumped there without major adverse effects on the surrounding environment will be limited.

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With regard to Site 1, the maximum thickness of material accumulated on the estuary bed after a single disposal operation was predicted to be 61.3 mm and it occurred over a single grid square when the material was disposed under minimum current velocity conditions. This compares with a maximum layer thickness of 44.7 mm when the material was disposed under maximum current velocity conditions. In the case of Site 2, the maximum thickness of material accumulated on the bed after a single dump was also found to occur under minimum velocity conditions with a thickness of 60.5 mm spread over a single grid square while a peak thickness of 33.3 mm was recorded under maximum current velocity conditions. It should also be noted that due to the shallow nature of Sites 1 and 2 the client will only access the sites at high water, thereby, maximising the depth of water within which dispersion and diffusion of the dumped material can occur.

5.4 Operational Considerations

Finally, in order to ascertain the effects of the full dredge disposal operation on the dump sites and their immediate surroundings, an attempt was made to estimate the

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likely maximum thicknesses of deposited material on the estuary bed following the disposal of the total volume of material expected to be dredged in a single year. The quantities of material arising from the dredging operations are presented in Table 5.1 and may be summarised as follows:

- Limerick Dock - 150,000 m^3

To calculate the likely maximum deposition at each site the approximate number of equivalent grid cells was calculated for each site based on the area of the site and the area of the grid cells used in the respective model simulations. The number of dumping operations required at each disposal site was then calculated based on the volume of material dumped during a single operation and the total volume to be dumped. It is assumed that the dumping operations will be spread evenly within the dump site in order to minimise the accumulation of dredge material. Therefore, using the equivalent number of grid cells for each site and the number of disposal operations required, an estimation of the likely maximum thickness of the deposited layer of dredge material was calculated for each disposal site based on the maximum thicknesses calculated by the model simulations for a single dumping operation. The results of these calculations are summarised in Table 5.1. The calculations were carried out for disposal of the dredge material under maximum current velocity conditions when the least amount of accumulation will occur.

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Dump Site	Area of Site [m^2]	Area of Cell [m^2]	Equiv. No. of Cells	Total Volume [m^3]	Single Volume [m^3]	No. of Dumps	Thickness after 1 Dump [m]	Maximum Thickness [m]
Site 1	52,500	10,000	5	75,000	294	255	0.04470	2.280
Site 2	45,000	10,000	5	75,000	294	255	0.03330	1.698

Table 5.1: *Summary of calculations to estimate the likely maximum thickness of deposited dredge material following disposal of total volume.*

From the table, it can be seen that extremely large accumulations of disposed material will occur on the estuary bed at both Dump Site 1 and 2, with maximum layer thicknesses predicted of 2.28 m and 1.698 m respectively. Given that the average water depths at Sites 1 and 2 are 2.88 m and 3.16 m respectively, at mean water level, the results indicate that the deposited layers of dredge material will become exposed at low water. These significant variations in bathymetry would also cause changes in

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the hydrodynamic regimes within the respective regions. The layer of deposited material is also thick enough to have major adverse effects on the flora and fauna within the respective areas. These adverse effects are discussed in a later section. These extremely large accumulations of dredge material are due to the shallow depths of water at the sites, the low current velocities and the large volume of material to be dumped there.

From the results discussed, it is readily apparent that Dump Sites 1 and 2 and their immediate vicinities will be affected by the dumping of dredge material. With careful management the total volume of dredge material to be disposed of could be distributed between the dump sites based on the predicted thickness of the deposited layers at each site for a single dumping operation.

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5.5 Ecological Impacts of Dredge Material Disposal

Regarding the biological implications of the disposal of the dredge spoil material, the deposition of 2 cm of material on top of a biologically active seabed will smother the benthic infauna. It is evident, therefore, that one of the results of the maintenance dredging activities in the Shannon will be to destroy any infauna at the dump sites. Due, however, to the fluctuating salinities which Sites 1 and 2 experience in response to freshwater flows from the River Shannon it is very likely that infauna at these sites is only present in small numbers. Also, given that there are extensive areas of seabed close by both dump sites which are colonised by the same types of species, it is expected that re-colonisation of the freshly deposited sediments will occur quite quickly.

With regard to the water column, it is clear that the dumping exercise will increase turbidity levels in the River Shannon. However, the zone of measurable impact will be limited to circa 100 m downstream of the dumpsite. Monitoring of suspended solids at other dredge disposal / extraction sites in Ireland has shown that levels fall to below background outside such a distance. Turbidity levels in the River Shannon can be high (McMahon & Quirke, 1992) especially in the vicinity of the upper estuary ca.

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from Limerick City to 40km westwards. They record levels of ca 80 mg/l in the vicinity of the area closest to Limerick City. In the lower part of the estuary, i.e. 40km west of Limerick City, the authors record ≤ 80 mg/l for suspended solids. Given the overall naturally high levels of suspended solids throughout the estuary, it is unlikely that the additional load contributed to the River Shannon during dredge disposal operations will have a significant negative impact on the biological communities in the water column.

CHAPTER 6
SUMMARY AND CONCLUSIONS

6.1 Summary

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In order to investigate the environmental effects caused by the proposed dredging of the Shannon Estuary and subsequent disposal of the dredged material within the estuary, two separate mathematical models were developed which simulated the transport and deposition of the disposed material at each of the proposed dump sites. These proposed sites are as follows:

- Dump Site 1 - Newtown Point
- Dump Site 2 - Coonagh Point

The mathematical model used for the study was the U.S. Army Corps of Engineers' Open Water Disposal Model (STFATE), which accounts for the physical processes determining the short-term fate of the dredged material disposed at open water sites.

In the case of each dump site, the bathymetry, the current velocity conditions and the characteristics of the dredged material were input to the models. For each site, the STFATE model was executed using two different hydrodynamic conditions, namely, maximum current velocities and minimum current velocities. The current velocity data at each of the dump sites were obtained from the Shannon Estuary Hydrodynamic Model which is already in existence and is owned by Shannon-Foynes Port Company.

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Finally, the model simulations were executed and the following conclusions were drawn based on the analysis of the results.

6.2 Conclusions

- Due to the shallow water depths at Dump Sites 1 and 2, execution of the models developed for the sites was not possible as a result of computational restrictions. This was true for water depths calculated at both mean water level and at spring high tide. However at spring high tide it was possible to execute the models using smaller volumes of dredge material than the volumetric capacity of the dredger. From these simulations a linear relationship was determined between the volume of material dumped and the resulting maximum thickness of the deposited material allowing the calculation of the peak thickness of accumulated material for the correct volume of dredge material.

- At Dump Site 1, under maximum velocity conditions, the maximum thickness of settled material after a single dump was calculated at 44.7 mm and occurred directly below the point of discharge. Under minimum velocity conditions, the maximum thickness of settled material after a single dump was calculated at 61.3 mm and also occurred directly below the point of discharge.

- At Dump Site 2, under maximum velocity conditions, the maximum thickness of settled material after a single dump was calculated at 33.3 mm and occurred directly below the point of discharge. Under minimum velocity conditions, the maximum thickness of settled material after a single dump was calculated at 60.5 mm and also occurred directly below the point of discharge.

- The likely maximum thicknesses of deposited dredge material at each of the Dump Sites, as predicted by the model simulations after a single dumping operation, are summarised in Table 6.1.

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Model Simulation	Maximum Thickness [mm]
Dump Site 1 - Maximum Velocity Simulation - Minimum Velocity Simulation	 44.7 61.3
Dump Site 2 - Maximum Velocity Simulation - Minimum Velocity Simulation	 33.3 60.5

Table 6.1: *Summary of model results for two proposed dump sites.*

- The deposition of 2 cm of material on top of a biologically active seabed will smother the benthic infauna, therefore, the maintenance dredging activities in the Shannon Estuary will destroy any infauna at all of the dump sites. However, re-colonisation of the freshly deposited sediments will occur quite quickly as there are extensive areas of seabed in the vicinity of both sites which are colonised by the same types of species.

- The dumping exercise will increase turbidity levels in the River Shannon. However, given the overall naturally high levels of suspended solids throughout the estuary and the limited zone of measurable impact (circa 100 m downstream of the dump site) it is unlikely that the additional turbidity resulting from the dredge disposal operations will have a significant negative impact on the biological communities in the water column.

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6.3 Recommendations

- Since the proposed dredging operations will require the re-use of the disposal sites, it is necessary to vary the dump location within the dump site area in order to ensure localised accumulations on the estuary bed are kept to a minimum. If this is adhered to then the likely maximum thickness of deposited material at each of the sites following the disposal of a year's worth of dredging operations is 2.28m at Site 1, 1.698 m at Site 2.

- It may be concluded, that careful management of the proposed dredge disposal operations within the Shannon Estuary will be extremely important in minimising the adverse effects of the dumping on both the hydrodynamic regimes and the flora and fauna within the proposed dump sites and their surrounding vicinities.

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SECTION 2

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IMPACT ASSESSMENT STUDY OF A DREDGE DISPOSAL SITE IN THE SHANNON ESTUARY AT FOYNES, CO. LIMERICK

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For: Shannon Foynes Port Company,
Mill House,
Foynes,
Co. Limerick.

By: Aqua-Fact International Services Ltd.,
12 Kilkerrin Park,
Liosbaun,
Galway.
www.aquafact.ie

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CHAPTER 1
INTRODUCTION

Aqua-Fact International Services Ltd. were commissioned by Shannon Foynes Port Company to carry out an impact assessment study of the environmental effects caused by maintenance dredging in the Shannon Estuary and subsequent disposal of the dredged material within the estuary at a proposed site near Foynes Island. Maintenance dredging is carried out to maintain the natural chart datum within the estuary as published on British Admiralty Charts for the area.

The purpose of the study was to model the transport and deposition of the disposed material in order to assess its impact on water quality and the estuary bed in the area surrounding the disposal site. This was achieved with the use of the U.S. Army Corps of Engineers' Open Water Disposal Model (STFATE) which accounts for the physical processes determining the short-term fate of the dredged material disposed at open water sites. The model provides estimates of water column concentrations of suspended sediment and the initial deposition of material on the estuary bed.

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All the relevant environmental and hydrodynamic data required as input to the model are described in Chapter 2. The theory, development and application of the model to analyse the short-term fate of the disposed material at the dump site is detailed in Chapter 3. Chapter 4 and Chapter 5, respectively, present and discuss the results obtained from the model simulations. Finally, in Chapter 6, the summary and conclusions of the project are presented and some recommendations are provided based on the study's conclusions.

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CHAPTER 2
MODEL DATA INPUT

2.1 Disposal Site

In order to keep the channels surrounding Foynes Island free of sediment built up, it is necessary to periodically carry out dredging operations. Table 2.1 details the amount of material which is required to be removed to maintain Chart Datum at the aforementioned locations (Shannon Foynes Port Company).

Location	Material	Quantity
Foynes Island	Mud/Silt	150,000 m^3

Table 2.1: *Details of proposed dredging operation.*

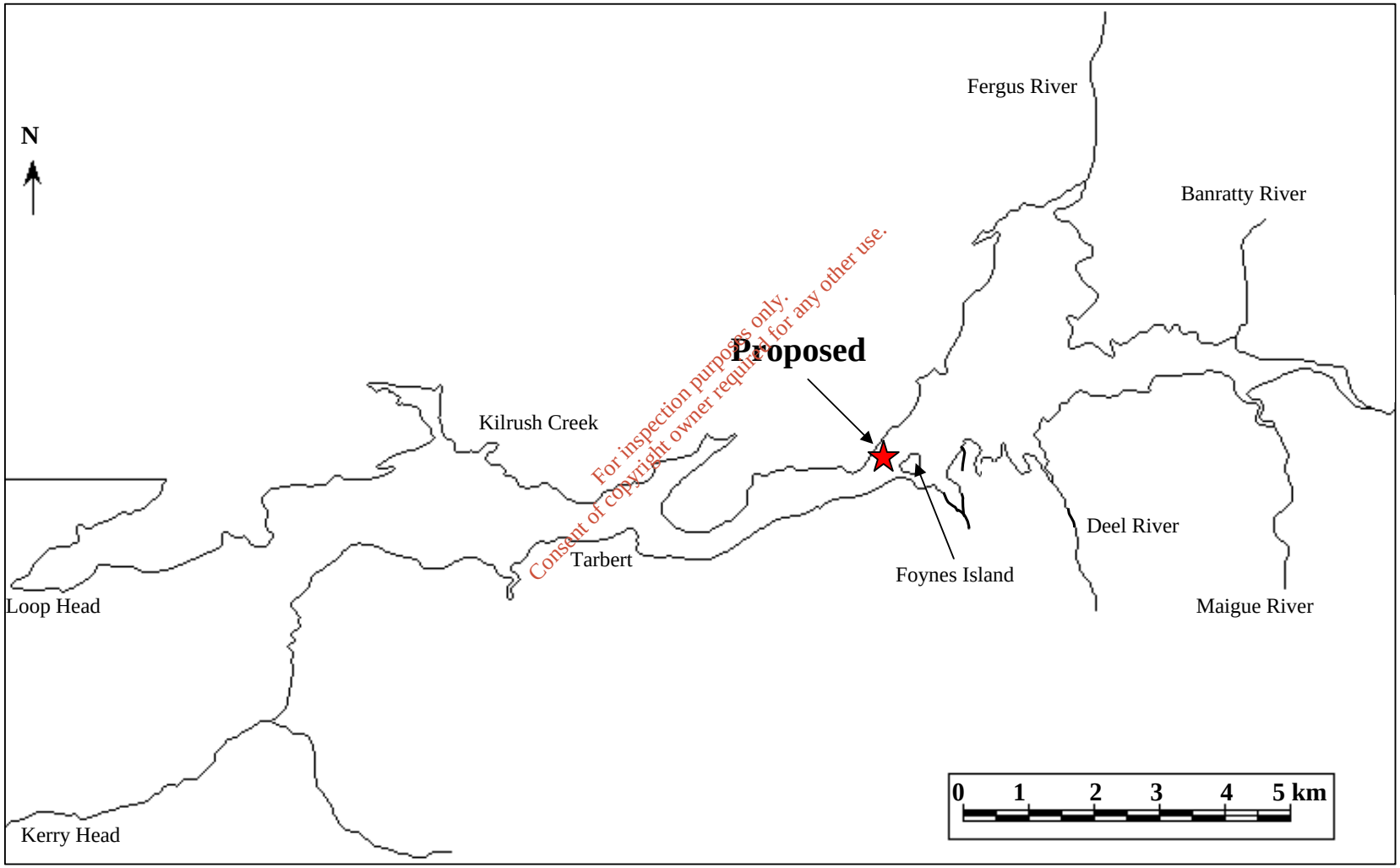
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It is proposed that the dredged material will be dumped at the disposal site shown in Figure 2.1. The coordinates of the site are 52° 37’ 19.8’’ N and 9° 08’ 33.2’’ W.

The bathymetric profile at the site was taken from the Admiralty Chart shown in Figure 2.2. The boundary of the dump site is highlighted in red. Part of the study area modelled using STFATE is indicated in Figure 2.2. The entire study area measures 7500m x 1500m and extends a further 5km downstream.

The STFATE model can only be run using a flat bed surface or one with a constant slope. Therefore, an average water depth was calculated for the extent of the study area. This figure was then used in model simulations.

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Figure 2.1: *Plan view of the Shannon Estuary showing the location of the proposed dump site.*

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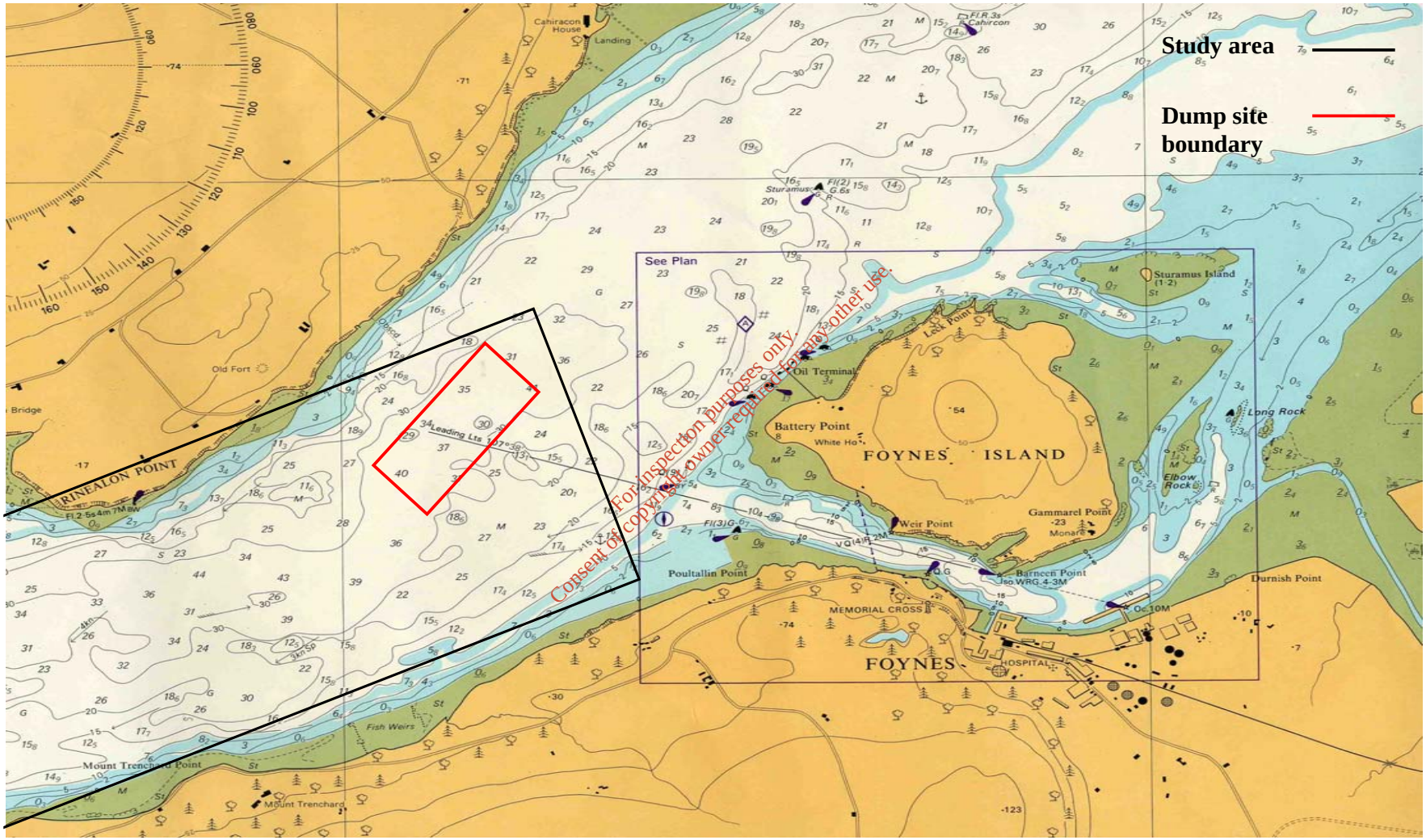


Figure 2.2 Admiralty Chart of section of Shannon estuary illustrating proposed dump site and study area modelled using STFATE

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2.2 Hydrodynamic Data

In studies investigating the impact of the disposal of dredged material there are two important considerations to take into account:

a) Whether the dredged material will be transported outside the boundary of the disposal site by the prevailing currents, which is most likely to occur when the currents are at a maximum.
b) Whether the build-up of dredged material on the sea bottom will significantly reduce the depth of water at the disposal site, which is most likely to occur when the currents are at a minimum.

With these considerations in mind, it was decided to analyse the disposal of the dredged material using two different hydrodynamic regimes, namely the maximum current velocity and minimum current velocity at each of the sites.

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The current velocity data at the dump site was obtained from the Shannon Estuary Hydrodynamic Model which is already in existence and is owned by Shannon Foynes Port Company. The model was executed and the current velocities and directions were computed and output at the proposed dump site for both spring and neap tidal conditions. From these plots of current velocity the maximum and minimum velocities were then calculated. The current data for spring tidal conditions were used in the model as current velocities reach their maximum during a spring tide. The current data input to the STFATE model are presented in Table 2.2.

Analysis	Description	Current Speed (m/s)	Current Direction (degrees from N)
1	Maximum Velocity	1.572	219.545
2	Minimum Velocity	0.019	163.600

Table 2.2: *Current data used in STFATE model simulations.*

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2.3 Dredged Material Data

Information on the properties of the dredged material to be disposed of was obtained from a site investigation carried out at Foynes. Shannon Foynes Port Company requested Enterprise Ireland's Shannon Laboratory to collect sediment samples and have them analysed for a range of specific parameters. In total, three samples were taken from Foynes on 15th August 2002. Analysis showed that the dredged material is composed of a mixture of sand and silt. The properties of the material (average of the three samples), as specified to the model, are presented in Table 2.3.

Location	Type	Spec. Gravity [mg/m^3]	Volumetric Conc.	Fall Vel. [m/s]	Deposited Void Ratio	Character
Foynes	Sand	2.70	0.1800	3.05×10^{-2}	0.6	Noncohesive
	Silt	2.65	0.3723	3.05×10^{-3}	4.5	Cohesive

Table 2.3: *Properties of dredged material input to model.*

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2.4 Disposal Operation Data

The disposal of dredged material will take place from a grab dredger with bottom opening doors for disposal. Although the dumping operation is considered to be instantaneous, it is assumed that the time to completely empty the dredging vessel will be approximately 3 ½ minutes. The input data specified to the model regarding the disposal operation are presented in Table 2.4 (Shannon Foynes Port Company, 2000).

Disposal Operation Detail	Value Input to Model
Mass of dredged material held in vessel ⇒ Volume of material	450 tonnes 234.3 m^3
Vessel length and width	43.6 x 9.9 m
Pre-disposal draft of vessel	3.2 m
Post-disposal draft of vessel	2.9 m
Angle of discharge	Vertical
Time to empty vessel	210 s
Vessel velocity	Stopped

Table 2.4: *Details of dredging operation data input to the model.*

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CHAPTER 3
MODEL THEORY AND DEVELOPMENT

3.1 Introduction

The objective of this study is to determine the impacts on the water column and the seabed of the disposal of dredged material at the proposed dump site. The initial phase of deposition of dredged material follows immediately upon release from the disposal vessel. Accurate representation of the initial mixing process of the dredged material is required to determine estimates of water column concentrations of suspended sediment and the initial deposition of the material on the bottom. In order to accurately represent the physics of the disposal, the mathematical model STFATE was employed to determine the characteristics of the initial mixing phase.

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3.2 Theory

In the STFATE model, the behaviour of the material is assumed to be separated into three phases:

1) ***convective descent***, during which the dump cloud or discharge jet falls under the influence of gravity and the initial momentum of the discharge;
2) ***dynamic collapse***, occurring when the descending cloud or jet impacts the bottom or arrives at a level of neutral buoyancy where descent is retarded and horizontal spreading dominates;
3) ***passive transport-diffusion***, commencing when the material transport and spreading are determined more by ambient currents and turbulence than by the dynamics of the disposal operation (U.S. EPA & U.S. Army Corps of Engineers, 1995). Figure 3.1 illustrates these three phases of material behaviour. The passive transport and diffusion phase in the model is handled by allowing the material settling from the descent and collapse phases to be stored in small Gaussian clouds. These clouds are then diffused and transported at the end of each time step.

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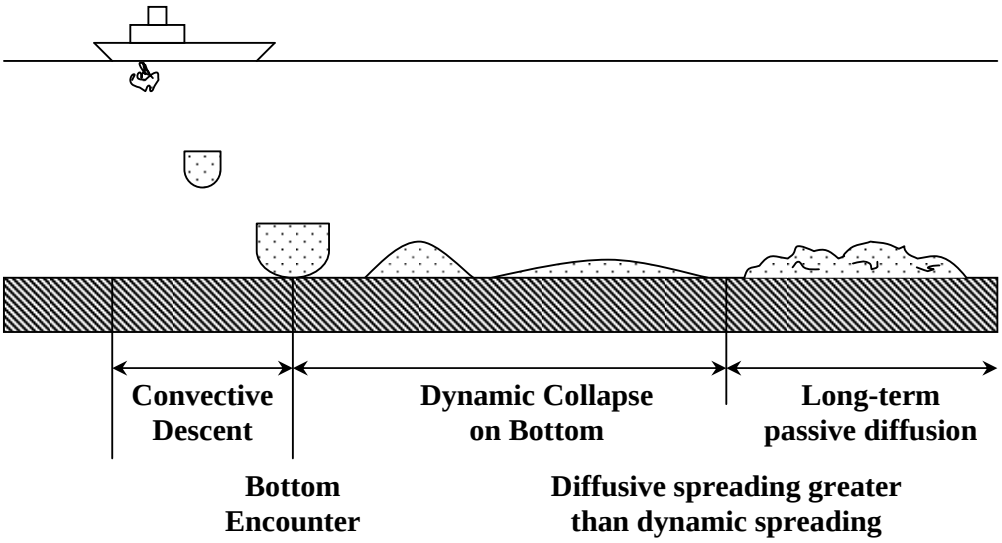


Figure 3.1: *The three stages of material behaviour as assumed in STFATE model (U.S. EPA & US Army Corps of Engineers, 1995).*

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3.3 STFATE Model Development

The study area was declared to the model in the form of a rectangular grid, details of which are given in Table 3.1. Each grid cell was then assigned the average depth that had been calculated for the entire study area. It should be noted that the average depth used in the models was calculated using a water depth at mean water level.

Dump Site	Grid Area [km^2]	Grid Spacing [m]	No. of Rows	No. of Columns	Depth [m]
Foynes	7.50 x 1.50	250 x 100	15	30	28.08

Table 3.1: *Grid size, spacing and depth used in model simulations.*

3.4 STFATE Model Analyses

Two different simulations were performed using the velocity conditions listed in Table 2.2. Each simulation predicted the initial deposition of dredged material resulting from a single disposal operation. The simulation time was equal to 1 hour

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for each model run. A period of 1 hour was chosen for simulations because it was observed that there was very little change in the amount of material settling on the seabed with time after this period had elapsed. The execution time step used during the model runs for the long-term transport-dispersion calculations was 100 seconds, which is the minimum timestep allowable in the model.

In each case the current velocities were assumed to be uniform over the entire water depth and were input to the model as depth averaged velocities. The velocities and directions were also assumed to be constant over the whole of the study area and for the full duration of the simulations.

3.5 STFATE Model Results

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Results from the STFATE model are presented using the following formats:

1) Graphs showing the development of the plume and its extent during the convective descent and cloud collapse phases.
2) Graphs showing the extent and movement of the plume of suspended material during the long-term transport-dispersion phase.
3) Three dimensional deposition plots of material on the seabed at the end of the simulation period.

With reference to the graphs presented in the following section, the x-direction corresponds to East-West, the y-direction corresponds to North-South and the z-direction represents water depth. The usual Cartesian convention applies with North and East corresponding to the positive y and x directions, respectively.

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CHAPTER 4
MODEL RESULTS AND DISCUSSION

In this chapter, the results of the STFATE model simulations for the two different hydrodynamic regimes are presented and discussed. Results are presented for each of the three physical processes represented in the model and described in Chapter 3 (convective descent, cloud collapse and long-term transport-diffusion). A discussion of these results is presented in Chapter 5 while conclusions drawn from them are presented in Chapter 6.

4.1 Foynes dump site

Convective Descent Results:

Analysis 1 – Maximum Velocity Condition: The duration of the convective descent phase was 5.27 seconds. At the end of this phase the plume centroid had moved 0.77m in the negative y-direction (southwards) and 4.39m from the barge in the negative x-direction (westward), while the downward velocity was 4.50m/s. The maximum radius of the plume achieved during this phase was 9.56m which can be compared to the initial plume radius of 5m.

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Analysis 2 – Minimum Velocity Condition: The duration of the convective descent phase was 5.18 seconds. At the end of this phase the plume centroid was 0.048 m from the barge in the negative y-direction and 0.015 m in the negative x-direction, while the downward velocity was 4.58m/s. The maximum radius of the plume achieved during this phase was 13.961m which can be compared to the initial plume radius of 5m.

Cloud Collapse Results:

Analysis 1 – Maximum Velocity Condition: The cloud collapse phase terminated 35.77 seconds after dumping. At the end of this phase the plume centroid was 7.60m

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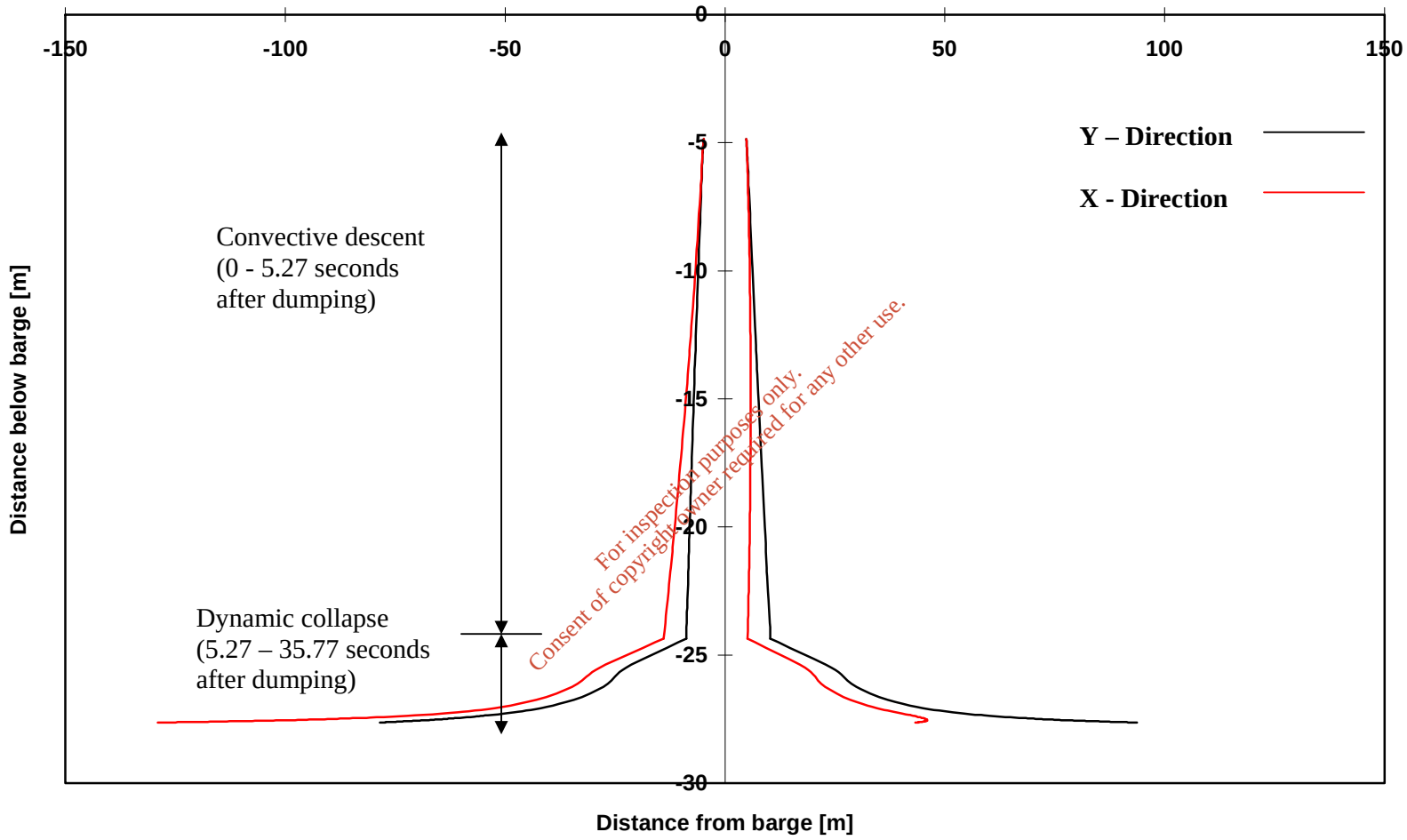
from the barge in the negative y-direction and 42.83m in the negative x-direction. The plume had a vertical thickness of 1.21 m and a diameter of 86.11 m. Figure 4.1 shows the radial extent and position relative to the barge of the plume as it sinks to the estuary bed.

Analysis 2 – Minimum Velocity Condition: The cloud collapse phase terminated 33.98 seconds after dumping. At the end of this phase, the plume centroid was located 0.063m from the barge in the negative y-direction and 0.018 m in the negative x-direction while the cloud had a thickness of 1.19m and a diameter of 84.44m. Figure 4.2 shows the radial extent and position relative to the barge of the plume as it sinks to the estuary bed.

From these results it can be seen that the speed of the ambient current has very little effect on both the downward velocity of the plume and its radius. Similarly, it has a negligible effect on the distance over which the plume will be transported during convective descent and dynamic collapse with the plume only moving a further 42.5 metres (approximately) in the negative x-direction for the increase in current speed from minimum to maximum conditions.

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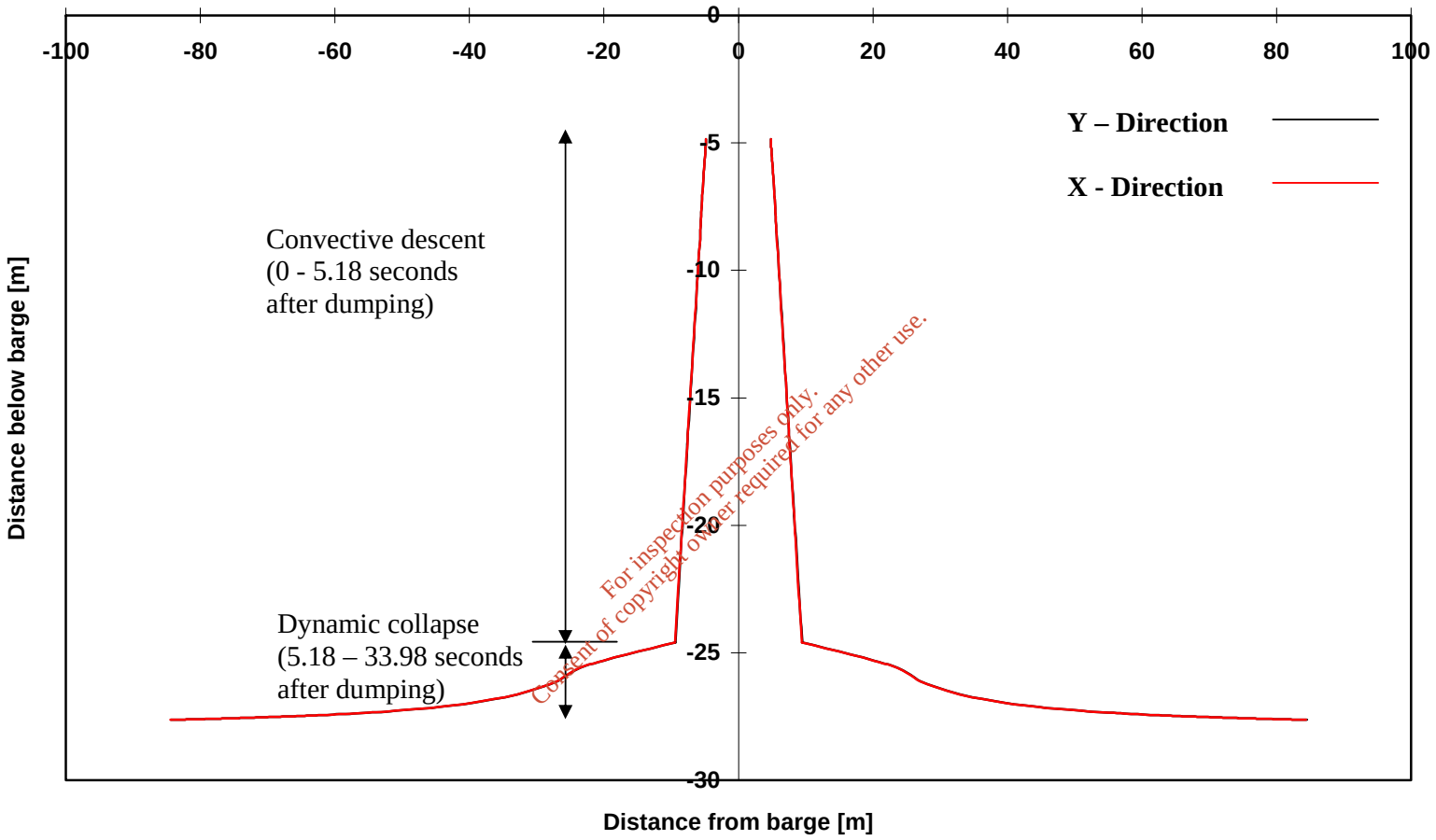
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Figure 4.1: *Development of plume extent during convective descent and cloud collapse phases – Analysis 1.*

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Figure 4.2: *Development of plume extent during convective descent and cloud collapse phases – Analysis* 2.

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Long-term Transport-Diffusion Results:

Analysis 1 – Maximum Velocity Condition

After 1 hour had elapsed 99.3% of the sand had settled to the estuary bed following discharge of the dredged material. With regard to the settling of the silt particles, at the end of the simulation period approximately 36.8.2 % had settled to the bed leaving 63.2 % still in a suspended state. After the one hour period, almost no change took place in the amount of material which settled to the bottom of the estuary bed indicating that a steady-state like condition had been reached.

Figure 4.3 shows the movement and growth of the discharge plume at the dump site due to the effects of ambient currents and diffusion during the course of the long-term transport-diffusion phase. Upon inspection of the diagram, it can be seen that the ambient current velocity has a very significant effect during this phase, transporting the plume approximately 5 km from the dump site after 1 hour. The diameter of the plume also increases significantly from 76.35 m (after 35.8 seconds) to 746.8m by the end of the simulation. It should be noted that from 1800 seconds after dumping, onwards, the plume is almost entirely composed of silt particles.

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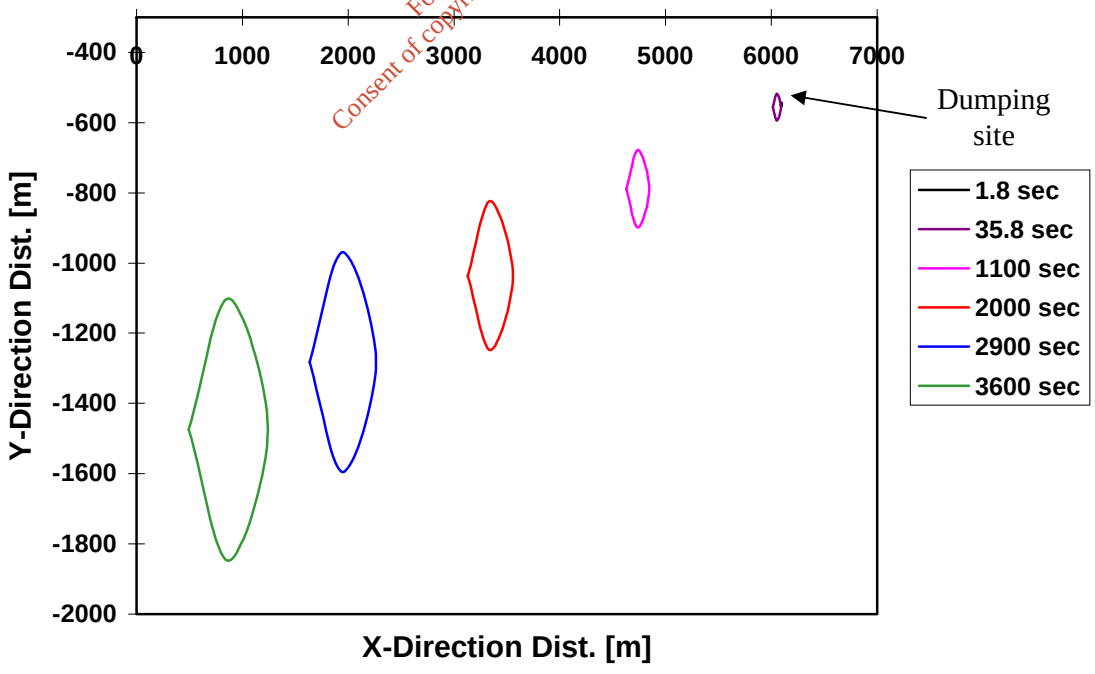
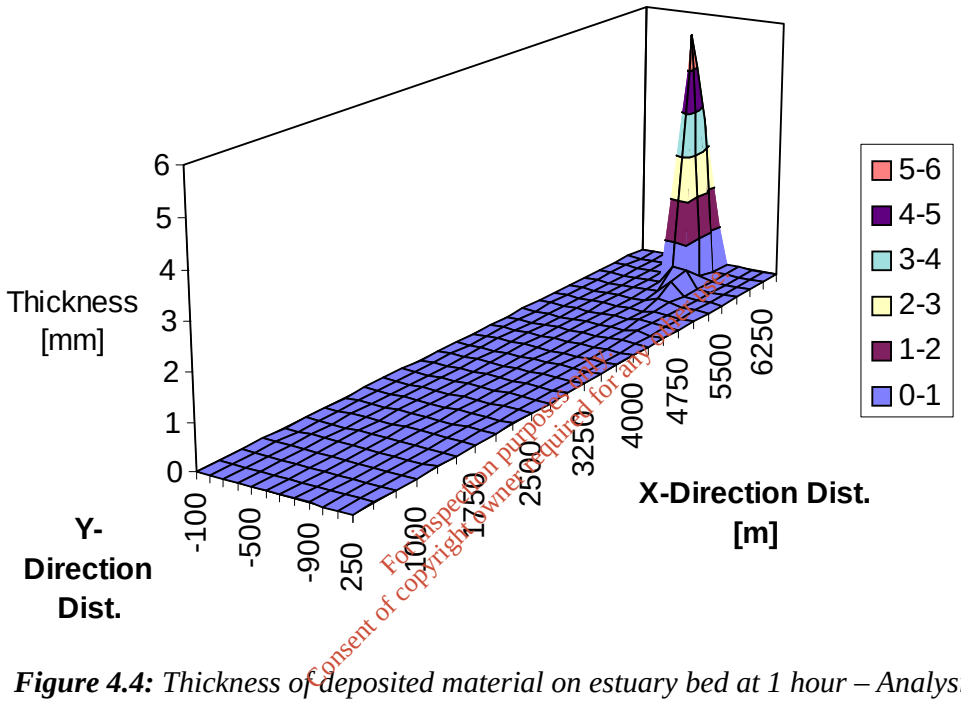


Figure 4.3: *Growth of plume during long-term transport-diffusion phase – Analysis 1.*

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At the end of the model simulation in Analyses 1, a peak thickness of 5.78 mm of deposited material was observed to accumulate over a single grid square under the site of the dumping operation. This 5.78 mm layer covers the entire grid square and is composed of both sand and silt. Figure 4.4 shows a three-dimensional deposition plot of the dumped material on the estuary bed within the study area at the end of the simulation period.



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Figure 4.4: *Thickness of deposited material on estuary bed at 1 hour – Analysis 1*

Analysis 2 – Minimum Velocity Condition

Unlike analysis 1, all of the disposed sand had settled to the bed surface by 1100 seconds after dumping. By the end of the simulation, approximately 82.3 % of the silt had also settled to the estuary bed leaving just 17.7 % of the silt still in suspension. Figure 4.5 shows the transport and growth of the plume of suspended material during the course of the transport-diffusion phase. As with analysis 1, almost no change took place in the amount of material which settled to the bottom of the estuary bed after 1 hour. As can be seen from the diagram, the plume did not move very much during this simulation. This was due to the very small current velocity employed in the analysis. However, the extent of the plume did increase by a

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fairly significant amount during the course of the transport-diffusion phase, growing from an initial diameter of 74.83 (after 34 seconds) to a diameter of 745.2m after 1hour.

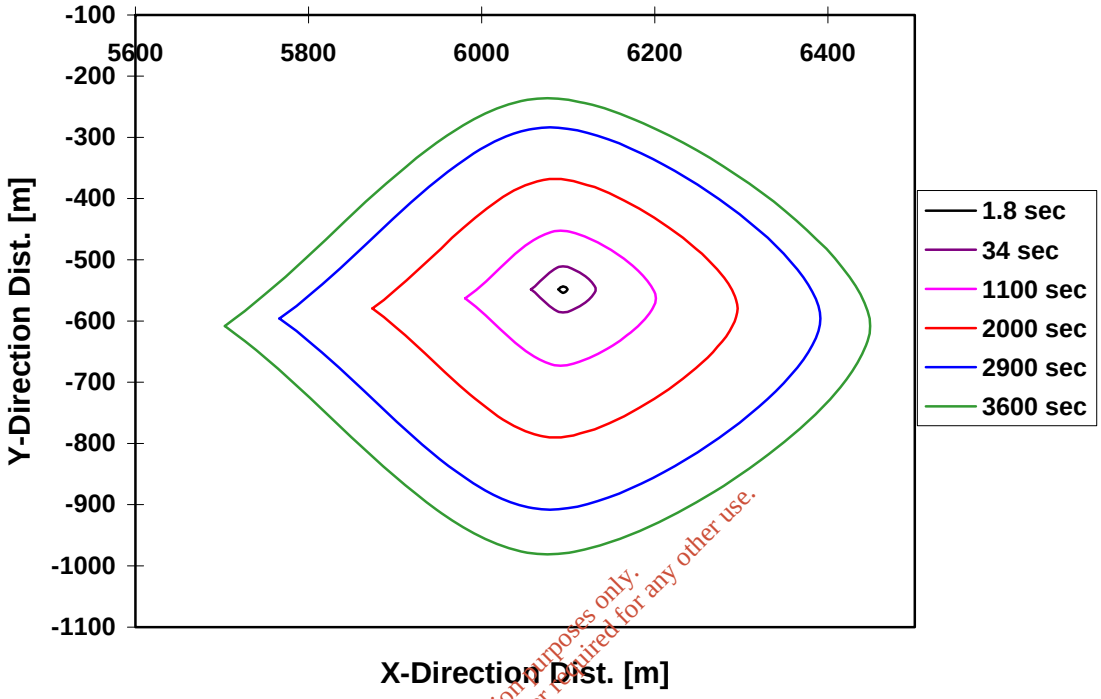


Figure 4.5: *Growth of plume during long-term transport-diffusion phase – Analysis 2.*

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With regard to the deposition of the dredged material, a peak thickness of 10.05mm of deposited material was observed to accumulate over a single grid square under the site of the dumping operation. As was the case with the previous simulations this 10.05mm layer covers the entire grid square.

Figure 4.6 gives a three-dimensional graphical representation of the deposited layer of dredged material at the end of the simulation (1 hour). When compared to Analysis 1 it can be seen that the peak thickness of the deposited layer is approximately 4.5 mm greater when the material is dumped under minimum current conditions than when it is dumped under maximum current conditions.

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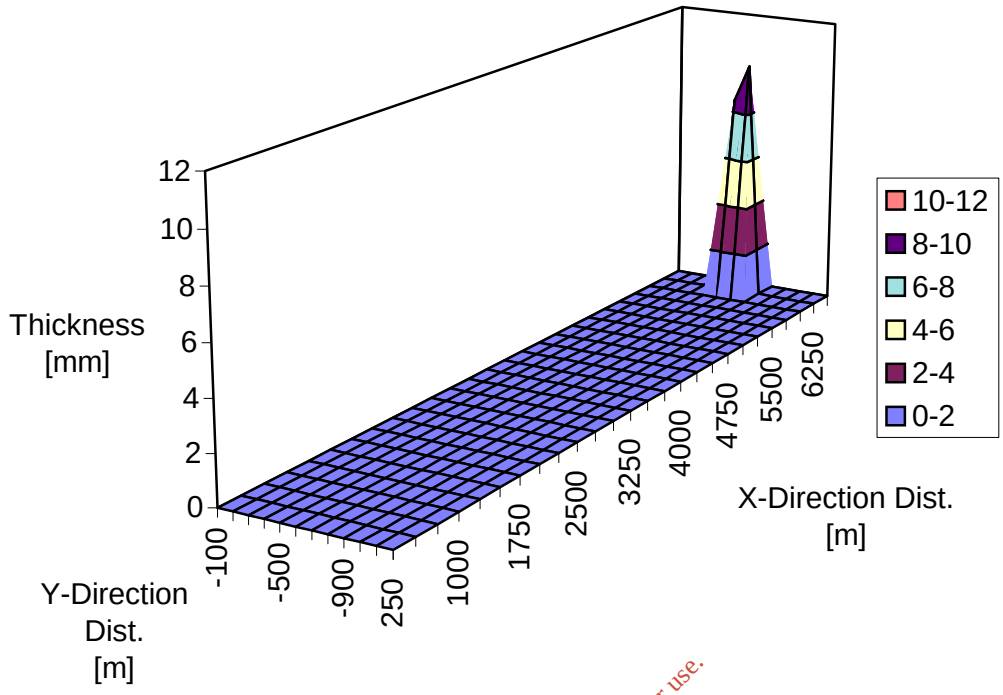


Figure 4.6: *Thickness of deposited material on estuary bed at 1 hour – Analysis 2.*

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CHAPTER 5
DISCUSSION OF RESULTS

The results of the model simulations carried out for the proposed dump site are discussed in this chapter. The results were analysed in such a way as to ascertain the possible impacts of the disposal of dredge material on water quality and the estuary bed in the area surrounding the disposal site. The following sections deal with the effect of current velocities on the transport and deposition of dredge material following its disposal and the ecological impacts of the disposal of dredge material within the Shannon Estuary.

5.1 Effects of Current Velocities

From the model results, it can be observed that the peak thickness observed in the simulation carried out under maximum current velocity conditions was lower than that observed under minimum velocity conditions. This is due to the fact that a greater proportion of material is transported away from the dump site prior to reaching the bed surface as a result of the stronger currents. The stronger the current therefore, the more even the distribution of settled dredged material on the bed surface. For the maximum velocity condition, it was observed that 63.2% of the silt was still in suspension. This implies that a significant quantity of the material will be settle far away from the original dump site. However, the rate of silt settlement near the end of the 1 hour period of simulation was extremely low and the maximum thickness which was deposited at this time was 0.03mm per grid square. This suggests that the remaining suspended material will settle out very gradually over a considerable area and some of it may even be transported out to sea. In either case, the sediment will have a negligible impact on the water depth when it does eventually settle. This suggests that the optimum time for disposal is at the time of maximum current speed at the dump site.

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5.2 Operational Considerations

The maximum thickness of material accumulated on the bed over a single grid square after a single disposal operation was predicted by the model to be 10.05 mm, or 0.010 m, for the

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lowest current velocity condition. The average water depth in this area is approximately 28.08 metres. The size of the dump site is approximately 224,000 m^2 and is, therefore, composed of about 9 grid squares (each grid square measures 250m x 100m). Therefore, depending on the number of dumping operations to be performed, they must be spread over the whole dump site area in such a way as to avoid large localised accumulations of dredged material.

In order to ascertain the effects of the full dredge disposal operation on the dump site and its immediate surroundings, an attempt was made to estimate the likely maximum thickness of deposited material on the estuary bed following the disposal of the total volume of material expected to be dredged in a single year.

To calculate the likely maximum deposition at the site the approximate number of equivalent grid cells was calculated for each site based on the area of the site and the area of the grid cells used in the model simulations. The number of dumping operations required at the disposal site was then calculated based on the volume of material dumped during a single operation and the total volume to be dumped. It is assumed that the dumping operations will be spread evenly within the dump site in order to minimise the accumulation of dredge material. Therefore, using the equivalent number of grid cells for each site and the number of disposal operations required, an estimation of the likely maximum thickness of the deposited layer of dredge material was calculated for the disposal site based on the maximum thickness calculated by the model simulations for a single dumping operation. The results of these calculations are summarised in Table 5.1. The calculations were carried out for disposal of the dredge material under maximum and minimum current velocity conditions.

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Analysis	Area of Site [m^2]	Area of Cell [m^2]	Equiv. No. of Cells	Total Volume [m^3]	Single Volume [m^3]	No. of Dumps	Thickness after 1 Dump [m]	Maximum Thickness [m]
1	224,200	25,000	9	150,000	234	641	0.00578	0.411
2	224,200	25,000	9	150,000	234	641	0.01005	0.715

Table 5.1: *Summary of calculations to estimate the likely maximum thickness of deposited dredge material following disposal of total volume.*

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From the Table 5.1, it is evident that the likely maximum thickness of the deposited layers are reasonably small, estimated at 411mm and 715mm, respectively. It is also apparent that disposal of the dredged material under maximum velocity conditions will result in a significantly smaller annual accumulation of sediment than that at minimum velocity conditions. It is not expected that these variations in bathymetry would have a significant impact on the hydrodynamic patterns within the associated regions. However, the deposited layers of dredge material are of sufficient thickness to adversely affect the flora and fauna of the associated areas, the extent of which is discussed in the following section.

5.3 Ecological Impacts of Dredge Material Disposal

Regarding the biological implications of the disposal of the dredge spoil material, the deposition of 0.4 m of sediment on top of the seabed will smother any benthic epi/infauna that is present. It is evident, therefore, that one of the results of the maintenance dredging activities at the Foynes site will be to destroy any epi/infauna there. Due, however, to the fact that samples collected at the site returned very low numbers of benthic invertebrates, the ecological impact of the disposal of dredge material will be low. The reasons for the low numbers of species maybe due to a number of factors and these include the fact that the site has been previously used as a disposal site and the possibility that salinity fluctuates. As there are extensive areas of seabed close by the dump site that presumably are colonised by the same suite of species as was recorded on the site, it is expected that re-colonisation of the freshly deposited sediments will occur quickly.

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With regard to the water column, it is clear that the dumping exercise will increase turbidity levels in the River Shannon. However, the zone of measurable impact will be limited to circa 500m downstream of the dumpsite. Monitoring of suspended solids at other dredge disposal/extraction sites in Ireland has shown that levels fall to below background outside such a distance. Turbidity levels in the River Shannon can be high (McMahon & Quirke, 1992) especially in the vicinity of the upper estuary ca. from Limerick City to 40km westwards. They record levels of ca 80 mg/l in the vicinity of the area closest to Limerick City. In the lower part of the estuary, i.e. 40km west of Limerick City, the authors record $\leq$ 80 mg/l for suspended solids. Given the overall naturally high levels of suspended solids throughout the estuary, it is unlikely that the additional load contributed to the River Shannon

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during dredge disposal operations will have a significant negative impact on the biological communities in the water column.

The Shannon is proposed as a Special Area of Conservation (pSAC) by Dúchas and this is primarily due to the fact that in the outer area i.e. west of Money Point, there is a pod of dolphins which is resident all year round. The proposed dredging and disposal activities at Foynes will not significantly negatively impact the status of the pSAC.

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CHAPTER 6
SUMMARY AND CONCLUSIONS

6.1 Summary

In order to investigate the environmental effects caused by the proposed dredging of the Shannon Estuary and subsequent disposal of the dredged material within the estuary, a mathematical model was developed which simulated the transport and deposition of the disposed material at the proposed dump site near Foynes Island.

The mathematical model used for the study was the U.S. Army Corps of Engineers' Open Water Disposal Model (STFATE) which accounts for the physical processes determining the short-term fate of the dredged material disposed at open water sites.

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The bathymetry, the current velocity conditions and the characteristics of the dredged material were input to the model. The STFATE model was executed using two different hydrodynamic conditions, namely, maximum current velocity and minimum current velocity. The current velocity data at the dump site were obtained from the Shannon Estuary Hydrodynamic Model which is already in existence and is owned by Shannon Foynes Port Company.

Finally, the model simulations were executed and the following conclusions were drawn based on the analysis of the results.

6.2 Conclusions

- At the dump site, under maximum velocity conditions, the disposal cloud struck the bottom in 5.27 seconds and grew from an initial radius of 5m to a final radius at the bottom encounter of 9.56m. Collapse on the bottom then occurred with the collapse phase terminating at 35.77 seconds after disposal and the final cloud having a diameter of 86.11m. Virtually all of the sand had settled to the bed after 1 hour while only 36.8 % of

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the silt had settled by the same time. The cloud of suspended solids had travelled approximately 5 km and had a diameter of 746.8m. The maximum thickness of the settled material after a single dump was recorded at 5.78mm directly beneath the point of dumping.

- At the dump site, under minimum velocity conditions, the disposal cloud struck the bottom in 5.18 seconds and grew from an initial radius of 5 m to a final radius at the bottom encounter of 13.96m. Collapse on the bottom then occurred with the collapse phase terminating 33.98 seconds and the final cloud having a diameter of 84.44 m. By the end the hour, 82.3 % of the silt had settled to the bed while all of the sand had settled. The total distance travelled by the cloud of suspended solids was negligible while its diameter grew to 745.2m. The maximum thickness of the settled material after a single dump was 10.05 mm and was recorded directly beneath the point of dumping.

- Although a large percentage of the dumped material was transported outside of the study area prior to settling under maximum velocity conditions, the rate of settlement was very low resulting in maximum deposition of silt 0.03mm thick (which corresponds to an annual figure of 2mm, which is insignificant). It is very likely that the majority of sediment will be dispersed over an extremely large area and that some of it will remain in suspension until it is washed out to sea. The quantities of silt which do settle are deemed to be small enough not to have a negative impact on water depths or flora and fauna.

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- For minimum velocity conditions, 17.7% of the silt remained in suspension at the end of the simulation. Again, a maximum thickness of 0.03mm of sediment was observed to be deposited at this stage of the simulation, indicating that the deposition rate was very low. As the velocity increases (with variation in the tides) it is expected that the silt in suspension will be well dispersed and settle out gradually without negative effects for water depths or flora and fauna.

- The maximum thickness of settled material was found to be significantly smaller when the dredged material was dumped under maximum velocity conditions as opposed to minimum velocity conditions.

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- The estimated annual deposition of material at the proposed dump site under maximum and minimum velocity conditions is 0.411m and 0.715m, respectively.

- The deposition of 0.4m of material on top of a biologically active seabed will smother and destroy any benthic epi/infauna at the dump site. However, due to the fact that samples collected at the site returned very low numbers of benthic invertebrates, the ecological impact of the disposal of dredge material will be low. Re-colonisation of the freshly deposited sediments will occur quite quickly as there are extensive areas of seabed in the vicinity of the site which are colonised by the same types of species.

- The dumping exercise will increase turbidity levels in the River Shannon. However, given the overall naturally high levels of suspended solids throughout the estuary and the limited zone of measurable impact (circa 500m downstream of the dump site), it is unlikely that the additional turbidity resulting from the dredge disposal operations will have a significant negative impact on the biological communities in the water column.

- The proposed dredging and disposal activities at Foynes will not significantly negatively impact the status of the proposed Special Area of Conservation (pSAC), west of Money Point.

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6.3 Recommendations

- Since the proposed dredging operations will require the re-use of the disposal site, it is necessary to vary the dump location within the dump site area in order to ensure localised accumulations on the estuary bed are kept to a minimum. If this is adhered to then the likely maximum thickness of deposited material at proposed the site following the disposal of a year's worth of dredging operations is 411mm.

- It may be concluded, that careful management of the proposed dredge disposal operations within the Shannon Estuary will be extremely important in minimising the adverse effects

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of the dumping on both the hydrodynamic regimes and the flora and fauna within the proposed dump sites and their surrounding vicinities.

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SECTION 3

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ENVIRONMENTAL SURVEY
AND SEDIMENT TRANSPORT MODEL
FOR A PROPOSED DUMP SITE IN SHANNON ESTUARY

SEPTEMBER 2005

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REPORT TO

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1. General Introduction

Aqua-Fact International services Ltd. were commissioned by Shannon Foynes Port Company to:

a) carry out an environmental assessment of a proposed dumpsite in the upper reaches of the Shannon Estuary prior to material being deposited there, and
b) develop a computer based model to simulate the fate of the disposal material on the dump ground.

The approaches to Limerick Dock and the Dock itself require maintenance dredging to maintain the necessary depth for ship traffic. It is proposed to deposit the material from this dredging exercise at a potential dump site in Shannon Estuary, close to Mellon Point (see Figure 1.1). The purpose of this study is firstly describe the environmental condition of the proposed dump site prior to any dumping exercise and secondly, model the transport and deposition of the disposed material in order to assess its impact on water quality and the sea bed in the area surrounding the disposal site.

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The results from these studies are presented in two parts in the following report. Part one deals with the environmental assessment of the site in terms of its floral and fauna composition and the importance of the site in terms of defining the ecological habitat of this area. The second part describes the process in constructing the model and presents the results of the model output, which predicts the fate of the disposed material.

The Shannon and Fergus Estuaries form the largest estuarine complex in Ireland. They form a unit stretching from the upper tidal limits of the Shannon and Fergus Rivers to the mouth of the Shannon estuary (considered to be a line across the narrow strait between Kilcredaun Point and Kilconly Point). Within this main unit there are several tributaries with their own sub-estuaries e.g. the Deel River, Mulkear River, and Maigue River. To

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the west of Foynes, a number of small estuaries form indentations in the predominantly hard coastline, namely Poulnasherry Bay, Ballylongford Bay, Clonderalaw Bay and the Feale or Cashen River Estuary.

The estuarine complex is a candidate SAC selected for lagoons and alluvial wet woodlands, both habitats listed on Annex I of the E.U. Habitats Directive. The site is also selected for floating river vegetation, *Molinia* meadows, estuaries, tidal mudflats, Atlantic salt meadows, Mediterranean salt meadows, *Salicornia* mudflats, sand banks, perennial vegetation of stony banks, sea cliffs, reefs and large shallow inlets and bays all habitats listed on Annex I of the E.U. Habitats Directive. The site is also selected for the following species listed on Annex II of the same directive; Bottle-nosed Dolphin, Sea Lamprey, River Lamprey, Brook Lamprey, Freshwater Pearl Mussel, Atlantic Salmon and Otter.

A site synopsis of this SAC is included as Appendix I.

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Part 1 Environmental Assessment of the Proposed Dumpsite

1 Introduction and Methodology

The proposed dumpsite is located south of Sod Island in the upper reaches of Shannon Estuary (Figure 1.1). The site co-ordinates are as follows:

A 52º 40.67' N 08º 51.14' W
B 52º 40.72' N 08º 50.69' W
C 52º 40.57' N 08º 51.11' W
D 52º 40.62' N 08º 50.66' W

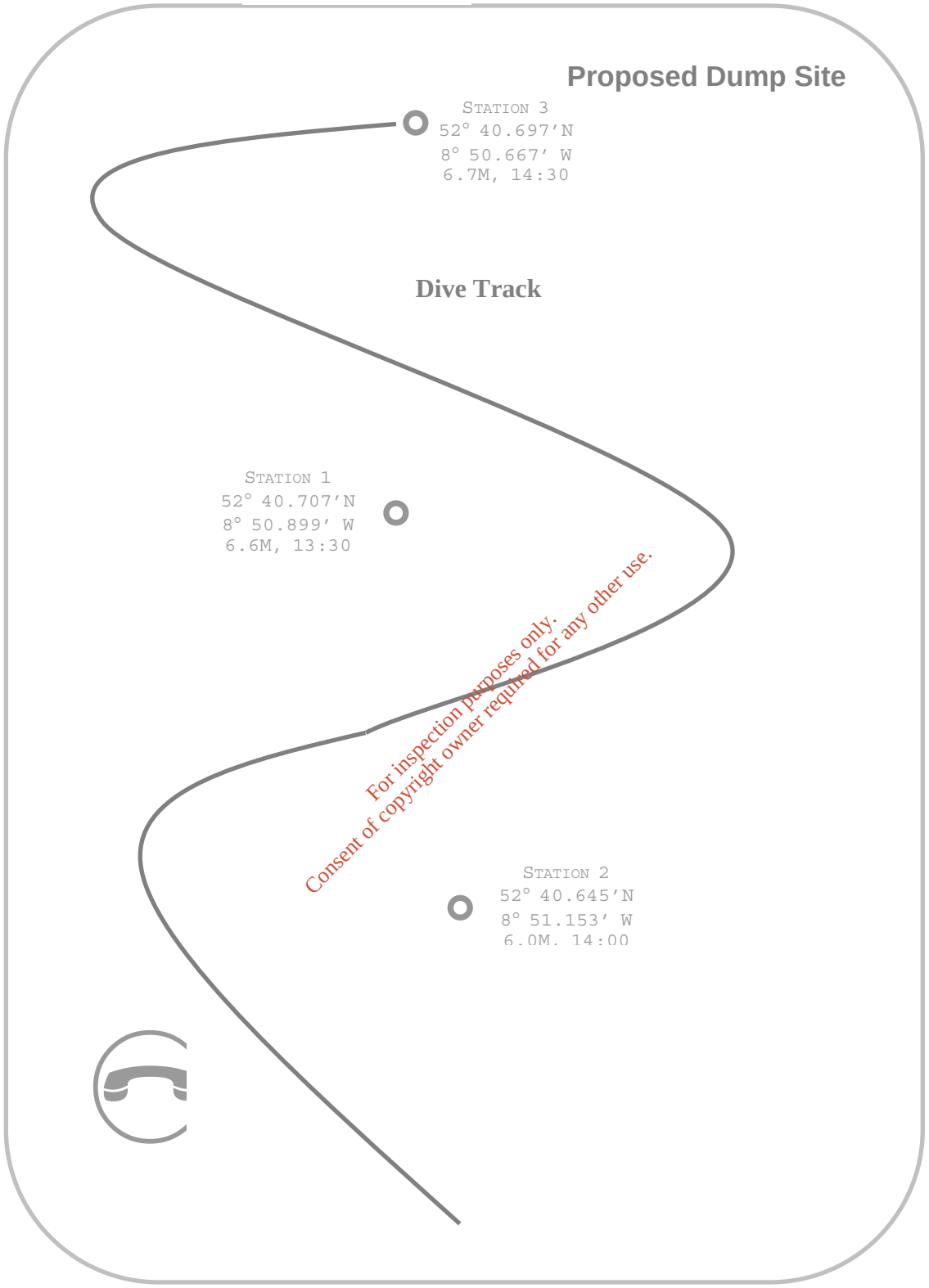
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An environmental survey was carried out at the site on 12th September 2005. This survey consisted of direct observations, with photographic records, by experienced scientific divers of bottom conditions within the proposed area of the site. The purpose of this survey was to document both the nature of the seabed and bottom conditions at the proposed dumpsite.

In addition, 3 replicate grab samples were taken at 3 locations within the site and retrieved for macrofaunal analysis (see Figure 1.2. for station locations). These benthic samples were taken by means of a small (0.025m^2) stainless steel Van Veen grab and fixed in formalin. On return to the laboratory, the samples were washed trough a 1mm diameter sieve and then backwashed into a sorting tray. The samples were individually sorted under a binocular microscope and fauna encountered were separated according to phyla (i.e. Annelida, Crustacea, Mollusca and other phyla). The fauna returned were later identified to species level using available taxonomic identification keys.

A fourth grab was taken at each of the stations and returned for graunlometric analysis.

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Figure 1.2: Dive survey track at the proposed dump site, Shannon Estuary, 12th September 2005.

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2. Results

2.1. Dive Survey

The dive survey began at the eastern side of the proposed dump site and continued in a zigzag fashion along the length of the site (see Figure 1.2). The dive was timed to coincide with high water when current velocity was at a minimum. Turbidity levels were high in the water column, which negated photograph records.

The dive survey was conducted at a depth of between 6-7 m on a relatively flat seabed composed predominantly of fine sand sediment. No reefs or rocky outcrops were encountered during the dive with the seabed surface formed into small sand waves by the action of the current. No macrofauna or algae were encountered during the survey.

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2.2. Grab Survey

2.2.1 Faunal Samples

Observations were made once the samples were taken aboard the boat. The sediment type at all the stations was described as reduced muddy sand with a surface layer of ca.1cm of oxidised medium sand. No smell of hydrogen sulphide was noted from the samples.

Biological analyses of the samples returned 12 taxa represented by 1 nematode, 5 polychaetes, 3 crustaceans and 3 bivalves as detailed in Table 2.1. No decapods or echinoderms were recorded. No rare or unusual species were recorded and the area sampled can be described as species-poor.

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Species	Station								
	1A	1B	1C	2A	2B	2C	3A	3B	3C
NEMATODA									
Nematoda sp.									1
ANNELIDA									
POLYCHAETA									
PHYLLODOCIDA									
Nephtyidae									
Nephtys sp.									1
SPIONIDA									
Spionidae									
Streblospio shrubsolii	1	2	1	7	12		9	3	
Cirratulidae									
Caulleriella zetlandica								1	
CAPITELLIDA									
Capitellidae									
Capitella capitata		4					1		
Arenicolidae									
Arenicola marina							2	1	
CRUSTACEA									
MYSIDACEA									
Mysidae									
Mesopodopsis slabberi						2			
AMPHIPODA									
Pontoporeiidae									
Bathyporeia pilosa	1	1	2			1			
Corophiidae									
Corophium arenarium	1		1						
MOLLUSCA									
BIVALVIA									
CARDIACEA									
Cardiidae									
Cerastoderma glaucum				1			2		1
MACTRACEA									
Mactridae									
Spisula solida					2				
MYACEA									
Myidae									
Mya arenaria								1	

Table 2.1. The macrofauna recorded from the grab samples, Shannon Estuary.

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2.2.2 Sediment Samples

The results of the particle size analysis on the sediment samples collected at each of the stations (see Figure 1.2) within the proposed dump site are presented in Table 2.2. These results reveal that the granulometric composition of the seafloor is varied ranging from a clean medium-fine sand in the centre of the box to muddier sediment on either end with sediments on the eastern side of the box having predominantly a muddy fine sand composition.

St	Gravel	Sand					Silt/Clay
		V.Coarse	Coarse	Medium	Fine	V. Fine	
	>2mm	0.85-2mm	0.5-0.85mm	0.25-0.5mm	0125-0.25mm	0.063-0.125mm	<0.63mm
1	-	-	0.06	36.14	59.50	1.78	2.28
2	-	-	0.30	20.50	54.22	5.69	19.53
3	-	-	-	0.99	33.03	28.29	37.69

Table 2.2. Results of the particle size analysis on the sediment samples collected at the proposed dump site, Shannon Estuary, 12th September 2005.

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3. Discussion

The proposed dumpsite is located in an area of the Shannon Estuary whose bottom features are neither unique nor critical to the overall habitat classification of this part of the estuary. Invertebrate species recorded such *as Streblospio shrubsolii*, *Bathyporeia pilosa* and *Cerastoderma glaucum* are common inhabitants of brackish waters in sheltered bays and estuaries such as the Shannon Estuary. The presence of polychaetes from the family Capitellidae such as *Capitella capitata* is a good indicator of organic enrichment and is tolerant of oxygen-stressed conditions.

According to Connor et al. (1997) the most suitable classification for this habitat type is estuarine sublittoral muds (IMU.EstMu). These are shallow sublittoral muds, extending from the extreme lower shore to about 15m depth in estuarine conditions. Characterising species for this type of habitat such as *Streblospio shrubsolii* and *Capitella capitata* were recorded.

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PART 2 SEDIMENT TRANSPORT MODEL FOR THE PROPOSED DREDGE DISPOSAL SITE IN THE SHANNON ESTUARY

1. Introduction

The purpose of this section of the study was to model the transport and deposition of the disposed material in order to assess its impact on water quality and the estuary bed in the area surrounding the disposal site. This was achieved with the use of the U.S. Army Corps of Engineers' Open Water Disposal Model (STFATE) (1995) which accounts for the physical processes determining the short-term fate of the dredged material disposed at water sites. The model provides estimates of water column concentrations of suspended sediment and the initial deposition of material on the estuary bed.

All the relevant environmental and hydrodynamic data required as input to the model are described in Chapter 2. The theory, development and application of the model to analyse the short-term fate of the disposed material at the dump site is detailed in Chapter 3. Chapters 4 and 5 present and discuss the results and conclusions obtained from the model simulations.

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2. Model Data Input

2.1 Disposal Site

In order to maintain the channel approaching Limerick Dock free of sediment build up, it is necessary to periodically carry out dredging operations. Table 2.1 details the estimated maximum amount of material which is required to be removed to maintain Chart Datum at the approach to and within Limerick Dock (Shannon Estuary Ports).

Location	Material	Quantity
Approach Channel	**Silt/Sand**	120,000 m^3
Limerick Dock	**Silt/Sand/Gravel**	6,000 m^3

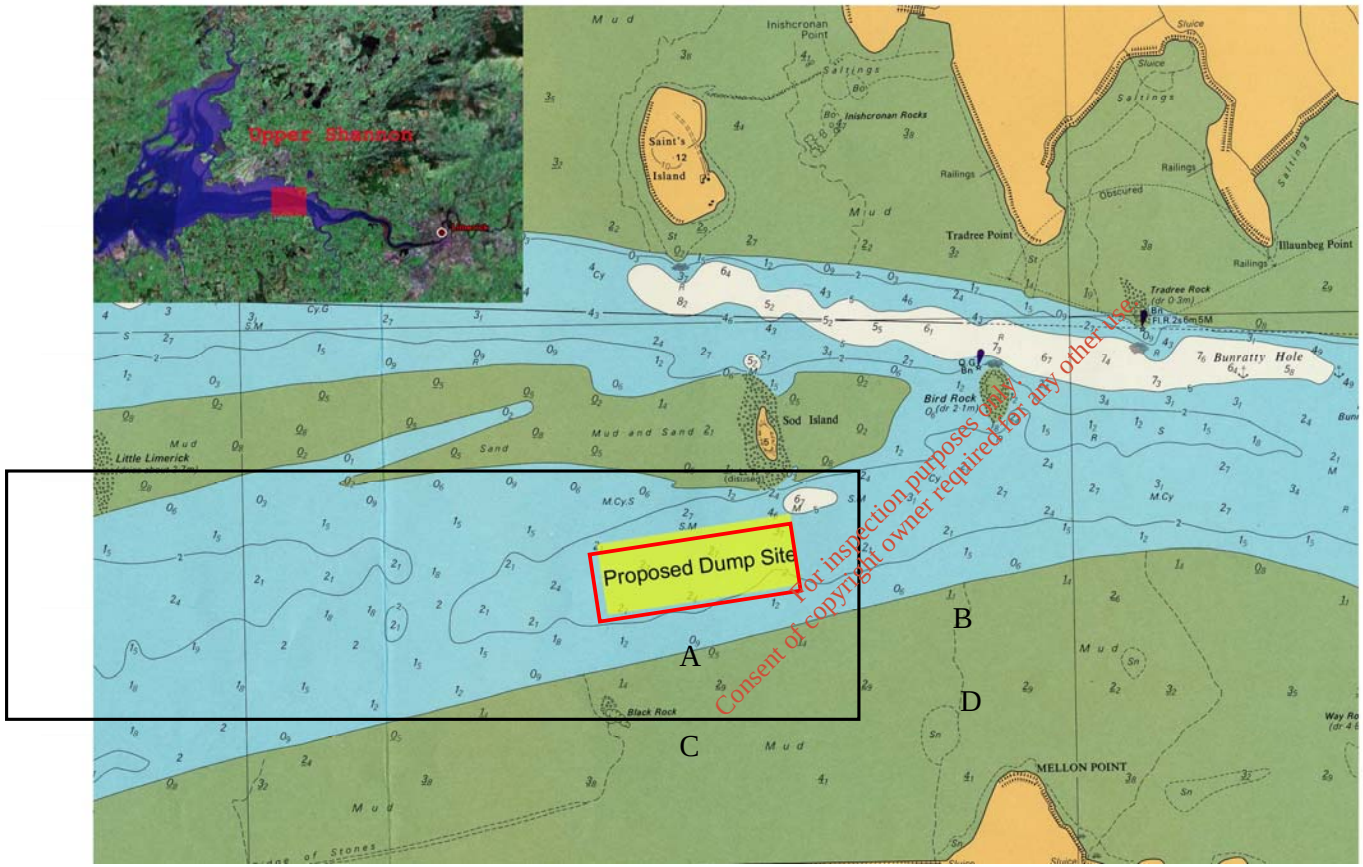
Table 2.1: Details of proposed dredging operation.

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The bathymetric profile at the proposed dump site was taken from the Admiralty Chart shown in Figure 2.1. The boundary of the dump site is highlighted in yellow. The coordinates of the site are A (52° 40.67' N and 8° 51.14' W), B (52° 40.72' N and 8° 50.69' W), C (52° 40.57' N and 8° 51.11' W), D (52° 40.62' N and 8° 50.66' W). The study area modelled using STFATE and measuring 2100m x 750m is also indicated in the diagram. A three dimensional plot of the bathymetry of the study area is shown in figure 2.2.

The STFATE model can only be run using a flat bed surface or one with a constant slope. Therefore, an average water depth was calculated for the extent of the study area. This figure was then used in model simulations.

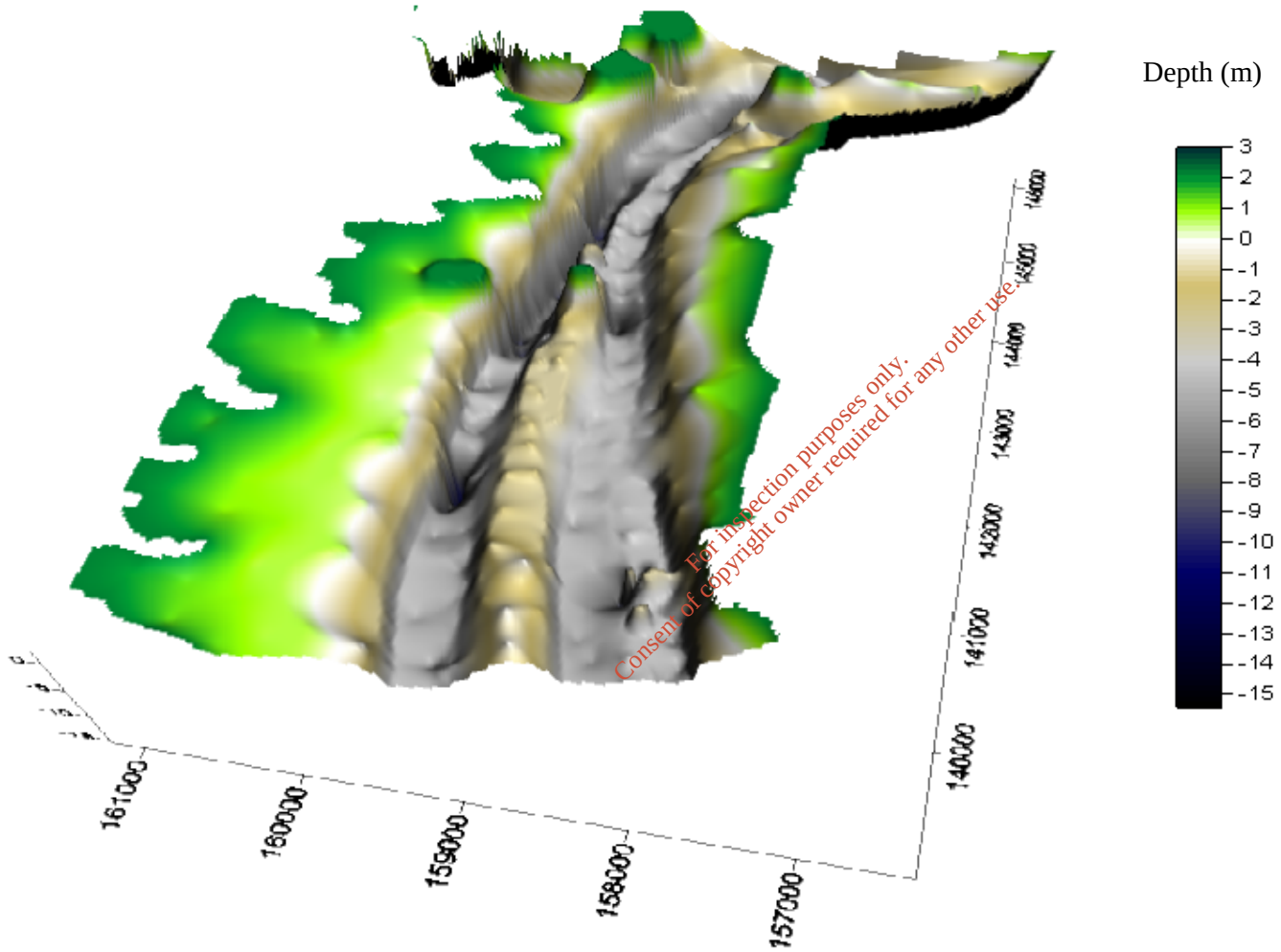
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Figure 2.1 Admiralty Chart of section of Shannon estuary illustrating proposed dump site and study area modelled using STFATE

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Figure 2.2- 3D bathymetric plot of section of Shannon estuary containing the dump site and study area modelled using STFATE

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2.2 Hydrodynamic Data

In studies investigating the impact of the disposal of dredged material there are two important considerations to take into account:

a) Whether the dredged material will be transported outside the boundary of the disposal site by the prevailing currents, which is most likely to occur when the currents are at a maximum.
b) Whether the build-up of dredged material on the sea bottom will significantly reduce the depth of water at the disposal site, which is most likely to occur when the currents are at a minimum.

With these considerations in mind, it was decided to analyse the disposal of the dredged material using two different hydrodynamic regimes, namely the maximum current velocity and minimum current velocity at each of the sites.

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The current velocity data at the dump site were obtained from the Shannon Estuary Hydrodynamic Model which is already in existence and is owned by Shannon Estuary Ports. The model was executed and the current velocities and directions were computed and output at the proposed dump site for both spring and neap tidal conditions. From these plots of current velocity, the maximum and minimum velocities were then calculated. The current data for spring tidal conditions were used in the model as current velocities reach their maximum during a spring tide. The current data input to the STFATE model are presented in Table 2.2.

Analysis	Description	Current Speed (m/s)	Current Direction (degrees from N)
1	Maximum Velocity	0.35	265.000
2	Minimum Velocity	0.01	0.000

Table 2.2: Current data used in STFATE model simulations.

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2.3 Dredged Material Data

Information on the properties of the dredged material to be disposed of was obtained from site investigations carried out at the Wet Dock in Limerick and at the approach channel to Limerick dock. Shannon Foynes Port Company requested Enterprise Ireland's Shannon Laboratory to collect sediment samples from these locations and have them analysed for a range of specific parameters. In total, three samples were taken from both locations. Analyses showed that the dredged material is composed of a mixture of sand and silt and gravel. The properties of this material are shown in table 2.3.

INSIDE DOCK	Site 1	Site 2	Site 3	Average	CHANNEL	Site 1	Site 2	Site 3	Average
% solids w/w	28.7	29.9	29.4	29.33	% solids w/w	42.2	36.8	46	41.67
% moisture w/w	71.3	70.1	70.6	70.67	% moisture w/w	57.8	63.2	54	58.33
>2mm	0	21.87	28.8	16.89	>2mm	0	0	0	0.00
2mm - 63um	9.43	6.25	1.24	5.64	2mm - 63um	4.88	10.18	15.48	10.18
<63um	90.57	71.88	69.96	77.47	<63um	95.12	89.82	84.52	89.82

Table 2.3: Physical parameters of sediment samples.

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Considering that a far greater quantity of dredged material comes from the approach channel than from inside the dock, the properties of the material, as specified to the model, are presented in Table 2.4.

Location	*Type*	Spec. Gravity [mg/m^3]	Volumetric Conc.	Fall Vel. [m/s]	Deposited Void Ratio	Character
Sod Island	Sand	2.70	0.0412	$3.05x10^{-2}$	0.6	Noncohesive
	Silt	2.65	0.3672	$3.05x10^{-3}$	4.5	Cohesive
	Gravel	2.70	0.0024	$3.05x10^{-1}$	99	Noncohesive

Table 2.4: Properties of dredged material input to model.

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2.4 Disposal Operation Data

The disposal of dredged material will take place from a grab dredger with bottom opening doors for disposal. Although the dumping operation is considered to be instantaneous, it is assumed that the time to completely empty the dredging vessel will be approximately 3 ½ minutes. The input data specified to the model regarding the disposal operation are presented in Table 2.5 (Shannon Estuary Ports, 2000).

Disposal Operation Detail	Value Input to Model
Mass of dredged material held in vessel ⇒ Volume of material	450 tonnes 234.3 m^3
Vessel length and width	43.6 x 9.9 m
Pre-disposal draft of vessel	3.2 m
Post-disposal draft of vessel	2.9 m
Angle of discharge	Vertical
Time to empty vessel	210 s
Vessel velocity	Stopped

Table 2.5: Details of dredging operation data input to the model.

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CHAPTER 3

MODEL THEORY AND DEVELOPMENT

3.1 Introduction

The objective of this study is to determine the impacts on the water column and the seabed of the disposal of dredged material at the proposed dump site. The initial phase of deposition of dredged material follows immediately upon release from the disposal vessel. Accurate representation of the initial mixing process of the dredged material is required to determine estimates of water column concentrations of suspended sediment and the initial deposition of the material on the bottom. In order to accurately represent the physics of the disposal, the mathematical model STFATE was employed to determine the characteristics of the initial mixing phase.

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3.2 Theory

In the STFATE model, the behaviour of the material is assumed to be separated into three phases:

1) ***convective descent***, during which the dump cloud or discharge jet falls under the influence of gravity and the initial momentum of the discharge;
2) ***dynamic collapse***, occurring when the descending cloud or jet impacts the bottom or arrives at a level of neutral buoyancy where descent is retarded and horizontal spreading dominates;
3) ***passive transport-diffusion***, commencing when the material transport and spreading are determined more by ambient currents and turbulence than by the dynamics of the disposal operation (U.S. EPA & U.S. Army Corps of Engineers, 1995). Figure 3.1 illustrates these three phases of material behaviour. The passive transport and diffusion phase in the model is handled by allowing the material

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settling from the descent and collapse phases to be stored in small Gaussian clouds. These clouds are then diffused and transported at the end of each time step.

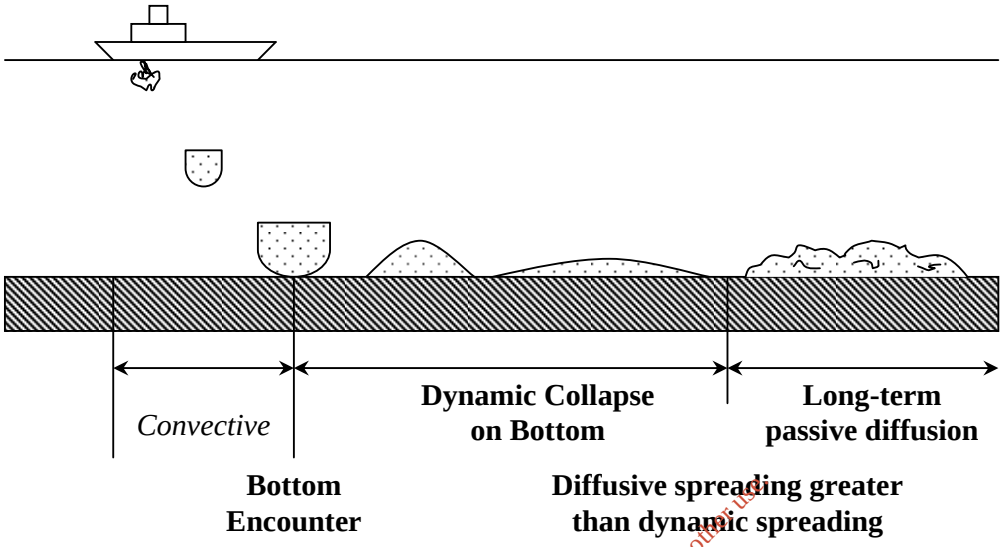


Figure 3.1: The three stages of material behaviour as assumed in STFATE model (U.S. EPA & US Army Corps of Engineers, 1995).

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3.3 STFATE Model Development

The study area was declared to the model in the form of a rectangular grid, details of which are given in Table 3.1. Each grid cell was then assigned the average depth that had been calculated for the entire study area. It should be noted that the average depth used in the models was calculated using a water depth at mean water level.

Dump Site	Grid Area [km^2]	Grid Spacing [m]	No. of Rows	No. of Columns	Depth [m]
Sod Island	2.10 x 0.75	60 x 30	25	35	4.2

Table 3.1: Grid size, spacing and depth used in model simulations.

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3.4 STFATE Model Analyses

Two different simulations were performed using the velocity conditions listed in Table 2.2. Each simulation predicted the initial deposition of dredged material resulting from a single disposal operation. The simulation time was equal to 1 hour for each model run. A period of 1 hour was chosen for simulations because it was observed that there was very little change in the amount of material settling on the seabed with time after this period had elapsed. The execution time step used during the model runs for the long-term transport-dispersion calculations was 100 seconds, which is the minimum timestep allowable in the model.

In each case the current velocities were assumed to be uniform over the entire water depth and were input to the model as depth averaged velocities. The velocities and directions were also assumed to be constant over the whole of the study area and for the full duration of the simulations.

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3.5 STFATE Model Results

Results from the STFATE model are presented using the following formats:

1) Graphs showing the development of the plume and its extent during the cloud collapse phase.
2) Graphs showing the extent and movement of the plume of suspended material during the long-term transport-dispersion phase.
3) Three dimensional deposition plots of material on the seabed at the end of the simulation period.

With reference to the graphs presented in the following section, the x-direction corresponds to East-West, the y-direction corresponds to North-South and the z-direction represents water depth. The usual Cartesian convention applies with North and East corresponding to the positive y and x directions, respectively.

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CHAPTER 4
MODEL RESULTS AND DISCUSSION

In this chapter, the results of the STFATE model simulations for the two different hydrodynamic regimes are presented and discussed. Results are presented for two of the three physical processes represented in the model and described in Chapter 3 (i.e. cloud collapse and long-term transport-diffusion). The depth was too shallow for the model to calculate convective descent results so this stage of the process was bypassed. A discussion of the results is presented in Chapter 5.

4.1 Results

Cloud Collapse Results:

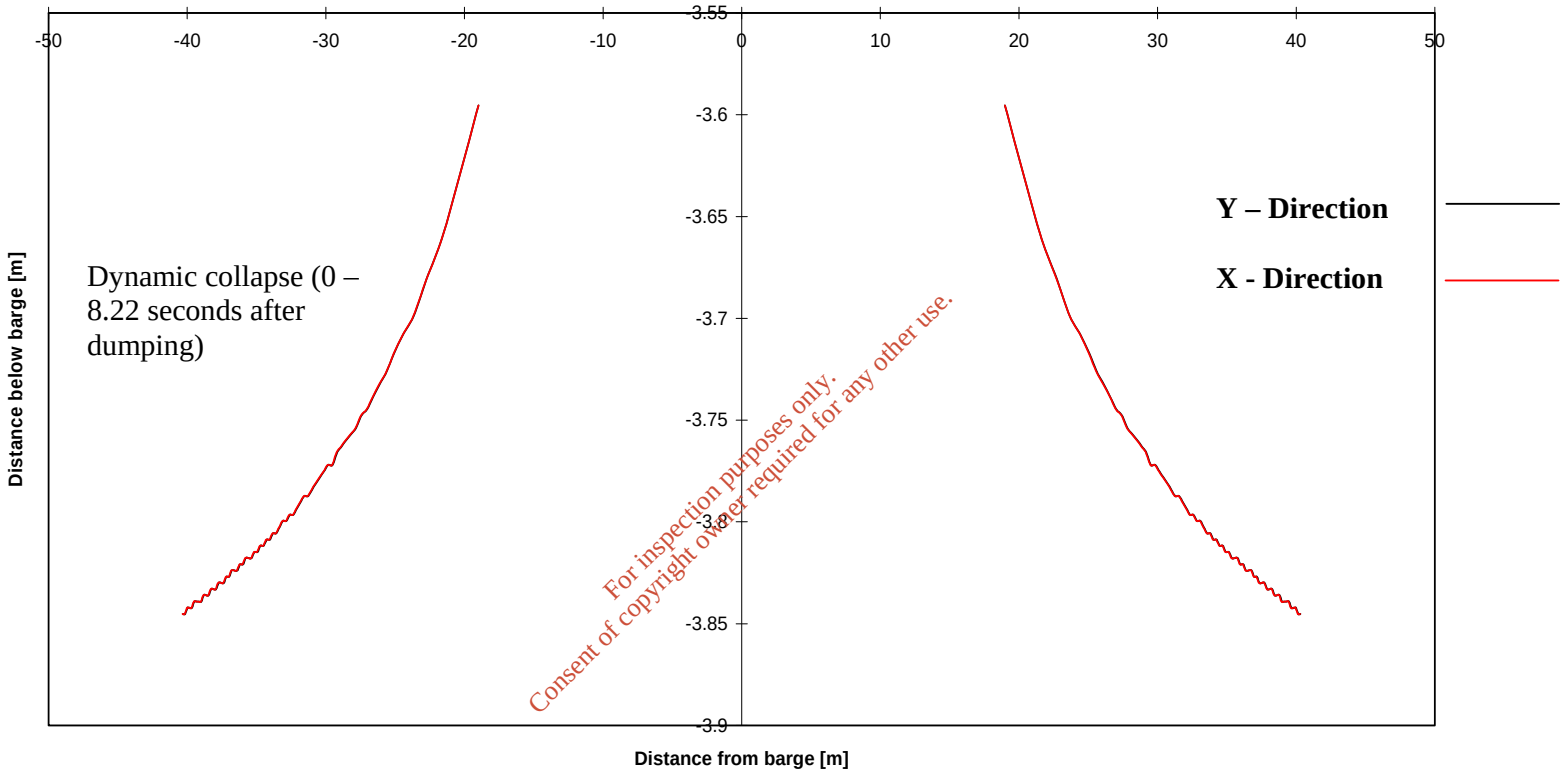
Analysis 1 – Maximum Velocity Condition: The cloud collapse phase terminated 8.22 seconds after dumping. At the end of this phase the plume centroid was 0.036m from the barge in the negative x-direction and 0.0m in the negative y-direction. The plume had a vertical thickness of 0.57 m and a diameter of 40.31 m. Figure 4.1 shows the radial extent and position relative to the barge of the plume as it sinks to the estuary bed.

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Analysis 2 – Minimum Velocity Condition: The cloud collapse phase terminated 8.22 seconds after dumping. At the end of this phase, the plume centroid had not moved from the barge in the negative x or y-direction while the cloud had a thickness of 0.57m and a diameter of 40.30m. Figure 4.2 shows the radial extent and position relative to the barge of the plume as it sinks to the estuary bed.

From these results it can be seen that the speed of the ambient current has very little effect on both the downward velocity of the plume and its radius. Similarly, it has a negligible effect on the distance over which the plume will be transported during convective descent and collapse. The reason for this is the shallow water depth.

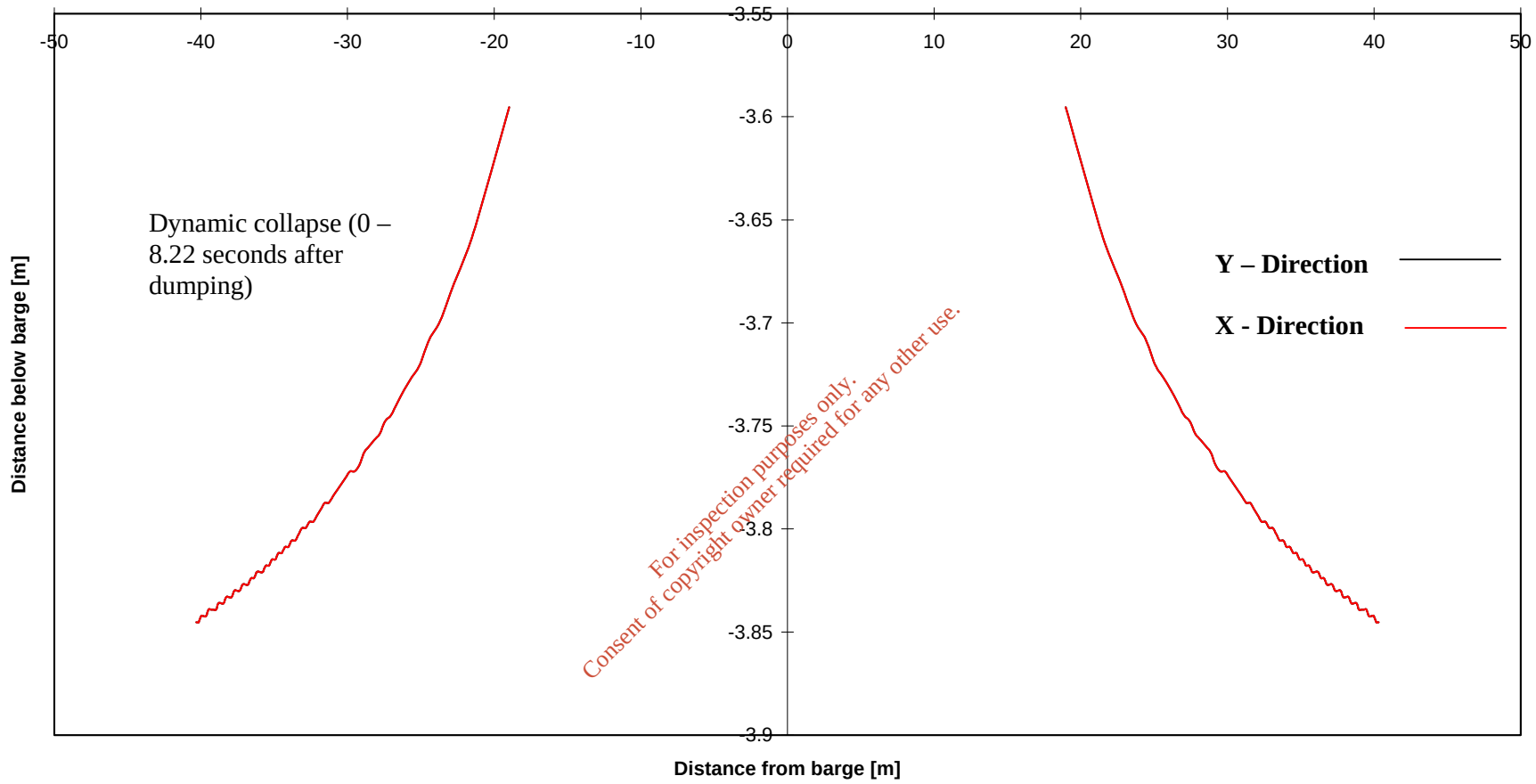
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Figure 4.1: Development of plume extent during cloud collapse phase – Analysis 1.

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Figure 4.2: Development of plume extent during cloud collapse phase – Analysis 2.

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Long-term Transport-Diffusion Results:

Analysis 1 – Maximum Velocity Condition

After 1 hour had elapsed all of the sand had settled to the estuary bed following discharge of the dredged material. With regard to the settling of the silt particles, at the end of the simulation period approximately 64.1 % had settled to the bed leaving 35.9 % still in a suspended state. After the one hour period, almost no change took place in the amount of material which settled to the bottom of the estuary bed indicating that a steady-state like condition had been reached.

Figure 4.3 shows the movement and growth of the discharge plume at the dump site due to the effects of ambient currents and diffusion during the course of the long-term transport-diffusion phase. Upon inspection of the diagram, it can be seen that the ambient current velocity has a significant effect during this phase, transporting the plume approximately 1.3 km from the dump site after 1 hour. The diameter of the plume also increases significantly from 35.77 m (after 8.3 seconds) to 696.8m by the end of the simulation. It should be noted that from 1000 seconds after dumping, onwards, the plume is almost entirely composed of silt particles.

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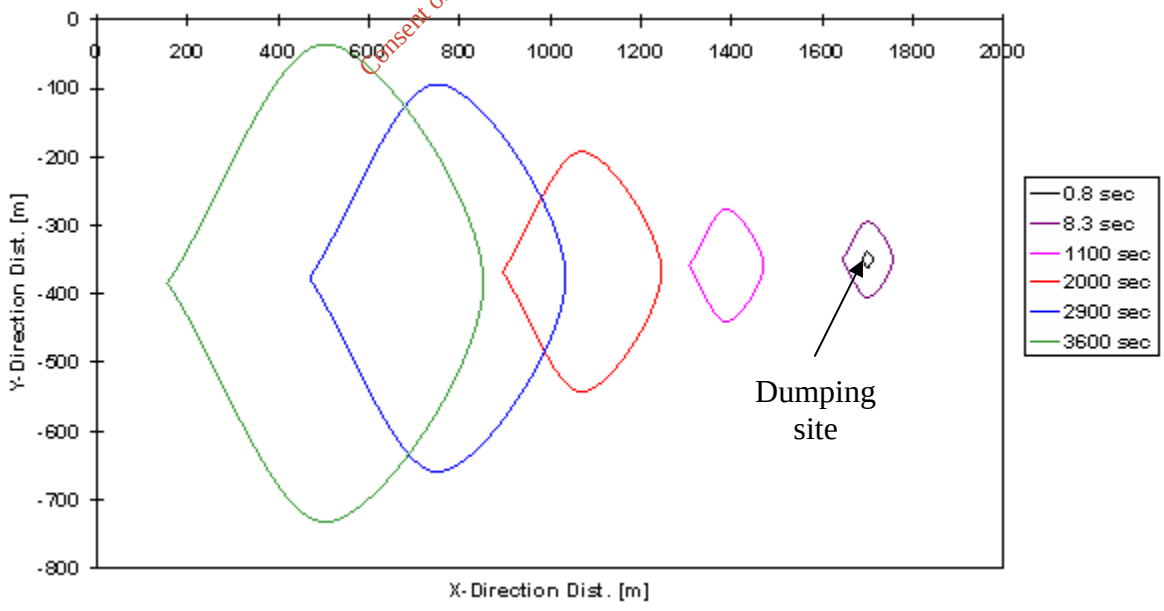
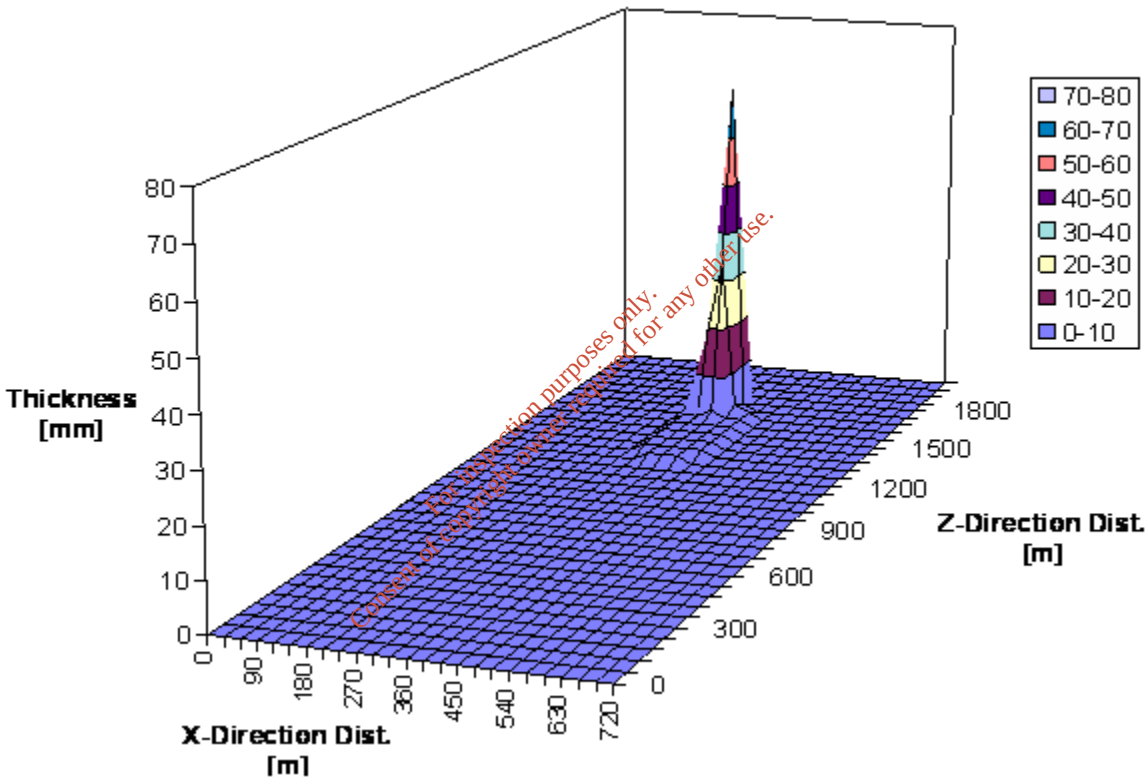


Figure 4.3: Growth of plume during long-term transport-diffusion phase – Analysis 1.

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At the end of the model simulation in Analyses 1, a peak thickness of 70.1 mm of deposited material was observed to accumulate over a single grid square under the site of the dumping operation. This 70.1 mm layer covers the entire grid square and is composed of both sand and silt. Figure 4.4 shows a three-dimensional deposition plot of the dumped material on the estuary bed within the study area at the end of the simulation period.



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Figure 4.4: Thickness of deposited material on estuary bed at 1 hour – Analysis 1

Analysis 2 – Minimum Velocity Condition

Unlike analysis 1, all of the disposed sand had settled to the bed surface by 500 seconds after dumping. By the end of the simulation, approximately 95.9 % of the silt had also settled to the estuary bed leaving just 4.1 % of the silt still in suspension. Figure 4.5

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shows the transport and growth of the plume of suspended material during the course of the transport-diffusion phase. As with analysis 1, almost no change took place in the amount of material which settled to the bottom of the estuary bed after 1 hour. As can be seen from the diagram, the plume did not move very much during this simulation. This was due to the very small current velocity employed in the analysis. However, the extent of the plume did increase by a fairly significant amount during the course of the transport-diffusion phase, growing from an initial diameter of 35.77 (after 8.3 seconds) to a diameter of 696.8m after 1hour.

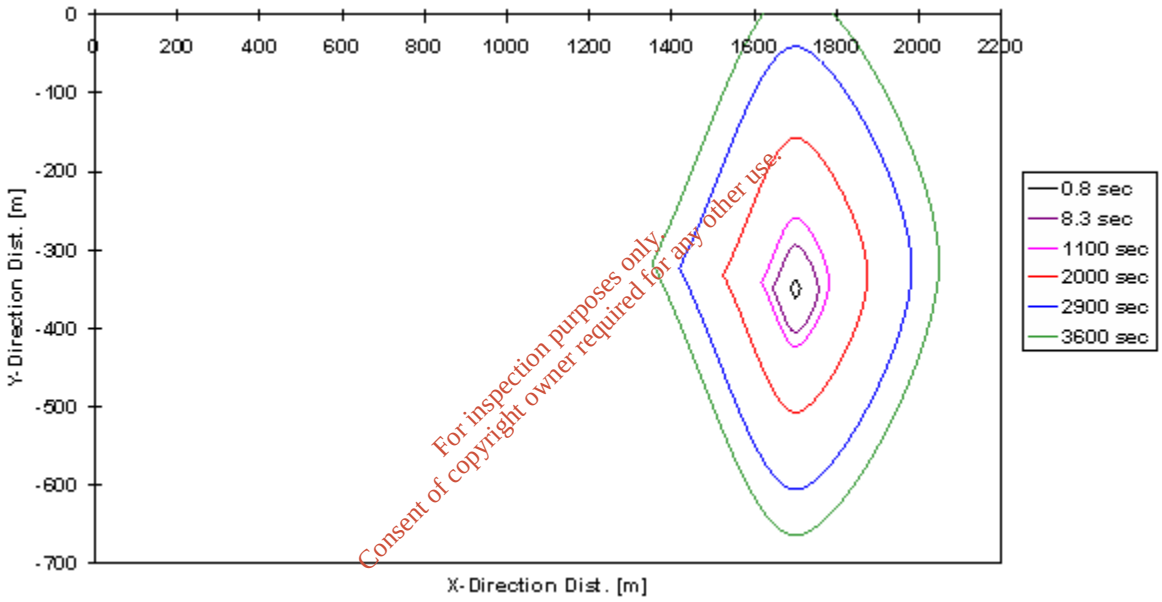


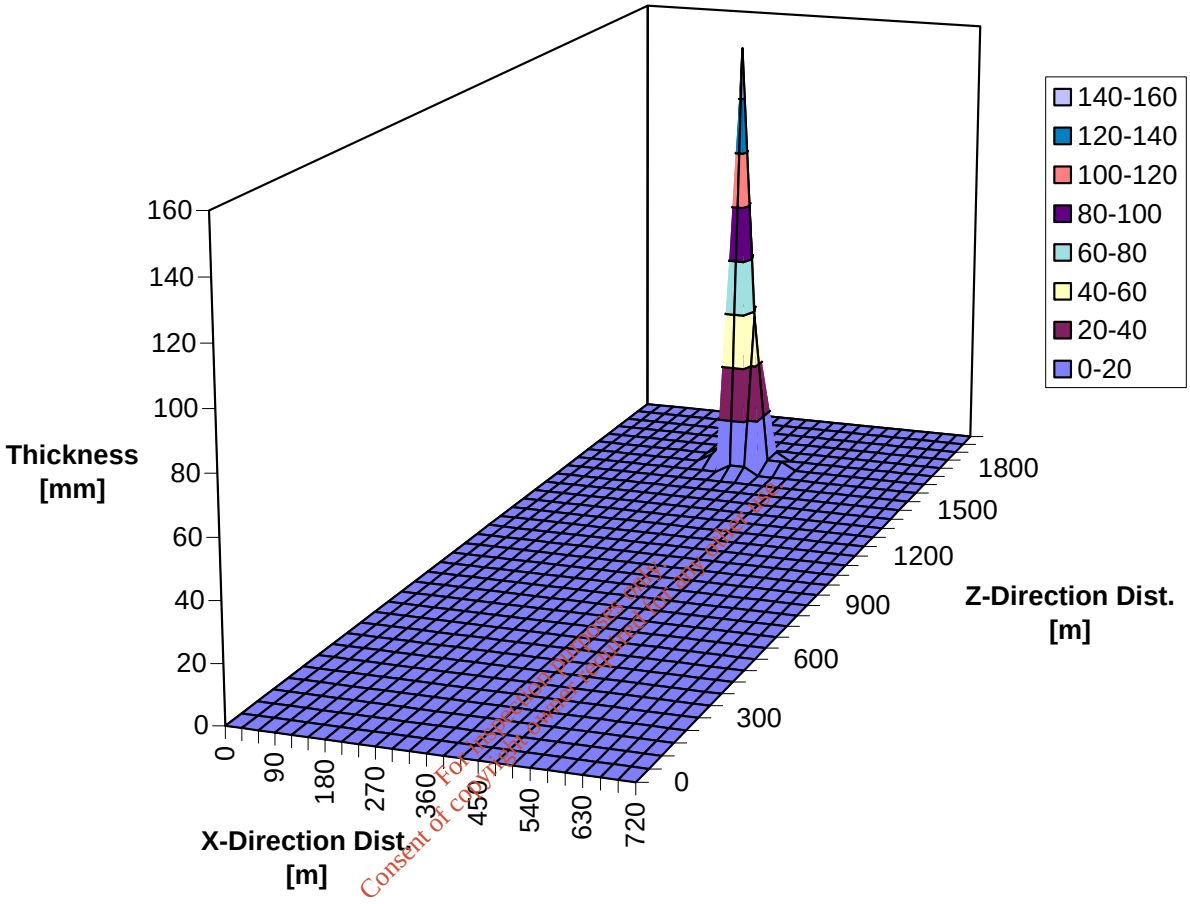
Figure 4.5: Growth of plume during long-term transport-diffusion phase – Analysis 2.

With regard to the deposition of the dredged material, a peak thickness of 158mm of deposited material was observed to accumulate over a single grid square under the site of the dumping operation. As was the case with the previous simulations this 158mm layer covers the entire grid square.

Figure 4.6 gives a three-dimensional graphical representation of the deposited layer of dredged material at the end of the simulation (1 hour). When compared to Analysis 1 it

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can be seen that the peak thickness of the deposited layer is more than twice as much when the material is dumped under minimum current conditions than when it is dumped under maximum current conditions.



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Figure 4.6: Thickness of deposited material on estuary bed at 1 hour – Analysis 2.

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CHAPTER 5
DISCUSSION OF RESULTS

The results of the model simulations carried out for the proposed dump site are discussed in this chapter. The results were analysed in such a way as to ascertain the possible impacts of the disposal of dredge material on water quality and the estuary bed in the area surrounding the disposal site. The following sections deal with the effect of current velocities on the transport and deposition of dredge material following its disposal.

5.1 Effects of Current Velocities

From the model results, it can be observed that the peak thickness observed in the simulation carried out under maximum current velocity conditions was lower than that observed under minimum velocity conditions. This is due to the fact that a greater proportion of material is transported away from the dump site prior to reaching the bed surface as a result of the stronger currents. The stronger the current, therefore, the more even the distribution of settled dredged material on the bed surface. For the maximum velocity condition, it was observed that 35.9% of the silt was still in suspension. This implies that a significant quantity of the material will settle far away from the original dump site. However, the rate of silt settlement near the end of the 1 hour period of simulation was extremely low and the maximum thickness which was deposited at this time was 0.05mm per grid square. This suggests that the remaining suspended material will settle out very gradually over a considerable area and some of it may even be transported out to sea. In either case, the sediment will have a negligible impact on the water depth when it does eventually settle. This suggests that the optimum time for disposal is at the time of maximum current speed at the dump site.

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5.2 Operational Considerations

The maximum thickness of material accumulated on the bed over a single grid square after a single disposal operation was predicted by the model to be 158 mm, or 0.158 m, for the lowest current velocity condition. The average water depth in this area is approximately 4.2 metres Chart Datum. The size of the dump site is approximately 100,000 m^2 and is, therefore, composed of about 55 grid squares (each grid square measures 60m x 30m). Therefore, depending on the number of dumping operations to be performed, they must be spread over the whole dump site area in such a way as to avoid large localised accumulations of dredged material.

In order to ascertain the effects of the full dredge disposal operation on the dump site and its immediate surroundings, an attempt was made to estimate the likely maximum thickness of deposited material on the estuary bed following the disposal of the total volume of material expected to be dredged.

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To calculate the likely maximum deposition at the site the approximate number of equivalent grid cells was calculated for each site based on the area of the site and the area of the grid cells used in the model simulations. The number of dumping operations required at the disposal site was then calculated based on the volume of material dumped during a single operation and the total volume to be dumped. It is assumed that the dumping operations will be spread evenly within the dump site in order to minimise the accumulation of dredge material. Therefore, using the equivalent number of grid cells for each site and the number of disposal operations required, an estimation of the likely maximum thickness of the deposited layer of dredge material was calculated for the disposal site based on the maximum thickness calculated by the model simulations for a single dumping operation. The results of these calculations are summarised in Table 5.1. The calculations were carried out for disposal of the dredge material under maximum and minimum current velocity conditions.

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Analysis	Area of Site [m^2]	Area of Cell [m^2]	Equiv. No. of Cells	Total Volume [m^3]	Single Volume [m^3]	No. of Dumps	Thickness after 1 Dump [m]	Maximum Thickness [m]
1	100,000	1,800	55	126,000	234	539	0.070	0.688
2	100,000	1,800	55	126,000	234	539	0.158	1.549

Table 5.1: Summary of calculations to estimate the likely maximum thickness of deposited dredge material following disposal of total volume.

From the Table 5.1, it is evident that the likely maximum thickness of the deposited layers are significant, estimated at 688mm and 1.549mm, respectively. It is also apparent that disposal of the dredged material under maximum velocity conditions will result in a significantly smaller accumulation of sediment than that at minimum velocity conditions. Given the relatively shallow water depth in the area these variations in bathymetry would have an impact on the hydrodynamic patterns within the associated regions.

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5.3 Recommendations

- Since the proposed dredging operations will require the re-use of the disposal site, it is necessary to vary the dump location within the dump site area in order to ensure localised accumulations on the estuary bed are kept to a minimum. If this is adhered to then the likely maximum thickness of deposited material at proposed the site following the disposal of the maximum worth of dredging operations is approximately 700mm.

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Conclusions

Maintenance dredging has been a necessary activity in the Shannon Estuary for many years with the requirement for ships navigated the channels in the estuary to unload their cargos at Limerick. The Shannon River carries large loads of suspended material to the estuary where it is deposited or remains in suspension resulting in high turbidity levels in the water column. McMahon (1988) reports on a turbidity maximum occurring between 14 km and 18 km from Limerick City when investigating suspended matter levels in the Shannon Estuary. From the data collected on suspended matter in the estuary McMahon and Quirke (1989) were able to come to a number of conclusions

a) a turbidity maximum is a regular and recurrent feature of the estuary
b) the geographic location of the maximum is variable but generally coincides with the location of the freshwater/seawater interface which can move up and down the estuary depending on the freshwater discharge and tidal state
c) the intensity of the maximum appears to depend on the tidal state, being greatest at spring tides and lowest at neap tides.

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The main physical and biological effects of disposal of the dredge spoil material on the dumpsite, which is contained within a SAC, are

1) smother the biological active seabed with the loss of resident infaunal community
2) increase turbidity levels at both the dredge site and disposal site
3) reduce the natural depth contours in the immediate vicinity of the dump site.

It is probable that each of these impacts will be short lived. As the environmental survey revealed, the proposed dumpsite is species poor and typical of estuarine sublittoral muds. Initially, all fauna buried by the disposed material will be smothered and lost. However, these species are common to the surrounding seabed and once disposal of the material has been completed, the deposited sediments will be re-colonised. Although, the dredging

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and disposal exercises will increase turbidity levels, similar studies have shown that the measurable impact will be less than 100 m downstream of the operation. These elevated levels will only be present during the physical acts of dumping and dredging and in the context of the overall natural high levels of suspended solids through the estuary, it is unlikely that the additional load will have significant negative impact.

As stated above, the bathymetry at the proposed dump site will change with shallower depths following dumping and an associated alternation in the hydrodynamic patterns within the immediate vicinity of the dumpsite. This is limited to the immediate area of the dumpsite and it is probable that, in time, a natural reduction will occur as currents will erode the material that stands proud of the natural seabed level immediately post dumping.

It may be concluded that careful management of the proposed dredge disposal operations within the Shannon Estuary will be extremely important in minimising the adverse effects of the proposed dredging and dumping and that these exercises will have minimum long term impacts on the SAC.

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Appendix I

Lower River Shannon (002165)

SITE NAME: Lower River Shannon

SITE CODE: 002165

This very large site stretches along the Shannon valley from Killaloe to Loop Head/ Kerry Head, a distance of some 120 km. The site thus encompasses the Shannon, Feale, Mulkear and Fergus Estuaries, the freshwater lower reaches of the River Shannon (between Killaloe and Limerick), the freshwater stretches of much of the Feale and Mulkear catchments and the marine area between Loop Head and Kerry Head. The Shannon and Fergus flow through Carboniferous limestone as far as Foynes, but west of Foynes Namurian shales and flagstones predominate (except at Kerry Head, which is formed from Old Red Sandstone). The eastern sections of the Feale catchment flow through Namurian Rocks and the western stretches through Carboniferous Limestone. The Mulkear flows through Lower Palaeozoic Rocks in the upper reaches before passing through Namurian Rocks, followed by Lower Carboniferous Shales and Carboniferous Limestone. The Mulkear River itself, immediately north of Pallas Green, passes through an area of Rhyolites, Tuffs and Agglomerates. Rivers within the sub-catchment of the Feale include the Galey, Smearlagh, Oolagh, Allaughaun, Owveg, Clydagh, Caher, Breanagh and Glenacarney. Rivers within the sub-catchment of the Mulkear include the Killeenagarriff, Annagh, Newport, the Dead River, the Bilboa, Glashacloonaraveela, Gortnageragh and Cahernahallia.

The site is a candidate SAC selected for lagoons and alluvial wet woodlands, both habitats listed on Annex I of the E.U. Habitats Directive. The site is also selected for floating river vegetation, *Molinia* meadows, estuaries, tidal mudflats, Atlantic salt meadows, Mediterranean salt meadows, *Salicornia* mudflats, sand banks, perennial vegetation of stony banks, sea cliffs, reefs and large shallow inlets and bays all habitats listed on Annex I of the E.U. Habitats Directive. The site is also selected for the following species listed on Annex II of the same directive ? Bottle-nosed Dolphin, Sea Lamprey, River Lamprey, Brook Lamprey, Freshwater Pearl Mussel, Atlantic Salmon and Otter.

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The Shannon and Fergus Estuaries form the largest estuarine complex in Ireland. They form a unit stretching from the upper tidal limits of the Shannon and Fergus Rivers to the mouth of the Shannon estuary (considered to be a line across the narrow strait between Kilcredaun Point and Kilconly Point). Within this main unit there are several tributaries with their own ?sub-estuaries? e.g. the Deel River, Mulkear River, and Maigue River. To the west of Foynes, a number of small estuaries form indentations in the predominantly hard coastline, namely Poulnasherry Bay, Ballylongford Bay, Clonderalaw Bay and the Feale or Cashen River Estuary.

Both the Fergus and inner Shannon estuaries feature vast expanses of intertidal mudflats, often fringed with saltmarsh vegetation. The smaller estuaries also feature mudflats, but have their own unique characteristics, e.g. Poulnasherry Bay is stony and unusually rich in species and biotopes. Plant species are typically scarce on the mudflats, although there are some Eel-grass beds (*Zostera* spp.) and patches of green algae (e.g. *Ulva* sp. and *Enteromorpha* sp.). The main macro-invertebrate community, which has been noted from the inner Shannon and Fergus estuaries, is a *Macoma-Scrobicularia-Nereis* community.

In the transition zone between mudflats and saltmarsh, specialised colonisers of mud predominate: swards of Common Cord-grass (*Spartina anglica*) frequently occur in the upper parts of the estuaries. Less common are swards of Glasswort (*Salicornia europaea* agg.). In the innermost parts of the estuaries, the tidal channels or creeks are fringed with species such as Common Reed (*Phragmites australis*) and Club-rushes (*Scirpus maritimus, S. tabernaemontani* and *S. triquetrus*). In addition to the nationally rare Triangular Club-rush (*Scirpus triquetrus*), two scarce species are found in some of these creeks (e.g. Ballinacurra Creek): Lesser Bulrush (*Typha angustifolia*) and Summer Snowflake (*Leucojum aestivum*).

Saltmarsh vegetation frequently fringes the mudflats. Over twenty areas of estuarine saltmarsh have been identified within the site, the most important of which are around the Fergus Estuary and at Ringmoylan Quay. The dominant type of saltmarsh present is Atlantic salt meadow occurring over mud. Characteristic species occurring include Common Saltmarsh Grass (*Puccinellia maritima*), Sea Aster (*Aster tripolium*), Thrift (*Armeria maritima*), Sea-milkwort (*Glaux maritima*), Sea Plantain (*Plantago maritima*), Red Fescue (*Festuca rubra*), Creeping Bent (*Agrostis stolonifera*), Saltmarsh Rush (*Juncus gerardi*), Long-bracted Sedge (*Carex extensa*), Lesser Sea-spurrey (*Spergularia marina*) and Sea Arrowgrass (*Triglochin maritima*). Areas of Mediterranean salt meadows, characterised by clumps of Sea Rush (*Juncus*

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maritimus) occur occasionally. Two scarce species are found on saltmarshes in the vicinity of the Fergus Estuary: a type of robust Saltmarsh-grass (*Puccinellia foucaudii*), sometimes placed within the compass of Common Saltmarsh-grass (*Puccinellia maritima*) and Hard-grass (*Parapholis strigosa*).

Saltmarsh vegetation also occurs around a number of lagoons within the site. The two which have been surveyed as part of a National Inventory of Lagoons are Shannon Airport Lagoon and Cloonconeen Pool. Cloonconeen Pool (4-5 ha) is a natural sedimentary lagoon impounded by a low cobble barrier. Seawater enters by percolation through the barrier and by overwash. This lagoon represents a type which may be unique to Ireland since the substrate is composed almost entirely of peat. The adjacent shore features one of the best examples of a drowned forest in Ireland. Aquatic vegetation in the lagoon includes typical species such as Beaked Tasselweed (*Ruppia maritima*) and green algae (*Cladophora* sp.). The fauna is not diverse, but is typical of a high salinity lagoon and includes six lagoon specialists (*Hydrobia ventrosa, Cerastoderma glaucum, Lekanesphaera hookeri, Palaemonetes varians, Sigara stagnalis* and *Enochrus bicolor*). In contrast, Shannon Airport Lagoon (2 ha) is an artificial saline lake with an artificial barrier and sluiced outlet. However, it supports two Red Data Book species of Stonewort (*Chara canescens* and *Chara cf. connivens*).

Most of the site west of Kilcredaun Point/Kilconly Point is bounded by high rocky sea cliffs. The cliffs in the outer part of the site are sparsely vegetated with lichens, Red Fescue, Sea Beet (*Beta vulgaris*), Sea Campion (*Silene maritima*), Thrift and Plantains (*Plantago* spp.). A rare endemic Sea Lavender (*Limonium recurvum* subsp. *pseudotranswallinum*) occurs on cliffs near Loop Head. Cliff-top vegetation usually consists of either grassland or maritime heath. The boulder clay cliffs further up the estuary tend to be more densely vegetated, with swards of Red Fescue and species such as Kidney Vetch (*Anthyllis vulneraria*) and Bird?s-foot Trefoil (*Lotus corniculatus*).

The site supports an excellent example of a large shallow inlet and bay. Littoral sediment communities in the mouth of the Shannon Estuary occur in areas that are exposed to wave action and also in areas extremely sheltered from wave action. Characteristically, exposed sediment communities are composed of coarse sand and have a sparse fauna. Species richness increases as conditions become more sheltered. All shores in the site have a zone of sand hoppers at the top and below this each of the shores has different characteristic species giving a range of different shore types in the pcSAC.

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The intertidal reefs in the Shannon Estuary are exposed or moderately exposed to wave action and subject to moderate tidal streams. Known sites are steeply sloping and show a good zonation down the shore. Well developed lichen zones and littoral reef communities offering a high species richness in the sublittoral fringe and strong populations of *Paracentrotus lividus* are found. The communities found are tolerant to sand scour and tidal streams. The infralittoral reefs range from sloping platforms with some vertical steps to ridged bedrock with gullies of sand between the ridges to ridged bedrock with boulders or a mixture of cobbles, gravel and sand. Kelp is very common to about 18m. Below this it becomes rare and the community is characterised by coralline crusts and red foliose algae.

Other coastal habitats that occur within the site include the following:

- stony beaches and bedrock shores - these shores support a typical zonation of seaweeds (*Fucus* spp., *Ascophyllum nodosum* and kelps).
- shingle beaches - the more stable areas of shingle support characteristic species such as Sea Beet, Sea Mayweed (*Matricaria maritima*), Sea Campion and Curled Dock (*Rumex crispus*).
- Sandbanks which are slightly covered by sea water at all times ? there is a known occurrence of sand/gravel beds in the area from Kerry Head to Beal Head.
- sand dunes - a small area of sand dunes occurs at Beal Point. The dominant species is Marram Grass (*Ammophila arenaria*).

Flowing into the estuaries are a number of tidal rivers.

Freshwater rivers have been included in the site, most notably the Feale and Mulkear catchments, the Shannon from Killaloe to Limerick (along with some of its tributaries, including a short stretch of the Kilmastulla River), the Fergus up as far as Ennis, and the Cloon River. These systems are very different in character: the Shannon being broad, generally slow-flowing and naturally eutrophic; the Fergus being smaller and alkaline; while the narrow, fast-flowing Cloon is acid in nature. The Feale and Mulkear catchments exhibit all the aspects of a river from source to mouth. Semi-natural habitats, such as wet grassland, wet woodland and marsh occur by the rivers, however, improved grassland is most common.

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One grassland type of particular conservation significance, *Molinia* meadows, occurs in several parts of the site and the examples at Worldsend on the River Shannon are especially noteworthy. Here are found areas of wet meadow dominated by rushes and sedges and supporting a diverse and species-rich vegetation, including such uncommon species as Blue-eyed Grass (*Sisyrinchium bermudiana*) and Pale Sedge (*Carex pallescens*).

Floating river vegetation characterised by species of Water-crowfoot (*Ranunculus* spp.), Pondweeds (*Potamogeton* spp.) and the moss *Fontinalius antipyretica* are present throughout the major river systems within the site. The rivers contain an interesting bryoflora with *Schistidium alpicola* var. *alpicola* recorded from in-stream boulders on the Bilboa, new to county Limerick.

Alluvial woodland occurs on the banks of the Shannon and on islands in the vicinity of the University of Limerick. The woodland is up to 50m wide on the banks and somewhat wider on the largest island. The most prominent woodland type is gallery woodland where White Willow (*Salix alba*) dominates the tree layer with occasional Alder (*Alnus glutinosa*). The shrub layer consists of various willow species with sally (*Salix cinerea* ssp. *oleifolia*) and what appear to be hybrids of *S. alba* x *S. viminalis.* The herbaceous layer consists of tall perennial herbs. A fringe of Bulrush (*Typha* sp.) occurs on the riverside of the woodland. On slightly higher ground above the wet woodland and on the raised embankment remnants of mixed oak-ash-alder woodland occur. These are poorly developed and contain numerous exotic species but locally there are signs that it is invading open grassland. Alder is the principal tree species with occasional Oak (*Quercus robur*), Elm (*Ulmus glabra, U. procera*), Hazel (*Corylus avellana*), Hawthorn (*Crataegus monogyna*) and the shrubs Guelder-rose (*Viburnum opulus*) and willows. The ground flora is species-rich.

Woodland is infrequent within the site, however Cahiracon Wood contains a strip of old Oak woodland. Sessile Oak (*Quercus petraea*) forms the canopy, with an understorey of Hazel and Holly (*Ilex aquifolium*). Great Wood-rush (*Luzula sylvatica*) dominates the ground flora. Less common species present include Great Horsetail (*Equisetum telmeteia*) and Pendulous Sedge (*Carex pendula*).

In the low hills to the south of the Slievefelim mountains, the Cahernahallia River cuts a valley through the Upper Silurian rocks. For approximately 2km south of Cappagh Bridge at Knockanavar, the valley sides are wooded. The woodland consists of Birch (*Betula* spp.), Hazel, Oak, Rowan (*Sorbus aucuparia*), some Ash (*Fraxinus excelsior*) and Willow (*Salix* spp.). Most of the valley is not grazed by stock, and as a result the trees are regenerating well. The ground flora feature prominent Greater wood-rush and Bilberry (*Vaccinium myrtillus*) with a typical range of woodland herbs. Where there is more light available, Bracken (*Pteridium aquilinum*) features.

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The valley sides of the Bilboa and Gortnageragh Rivers, on higher ground north east of Cappamore, support patches of semi-natural broadleaf woodland dominated by Ash, Hazel, Oak and Birch. There is a good scrub layer with Hawthorn, Willow, Holly and Blackthorn (*Prunus spinosa*) common. The herb layer in these woodlands is often open with a typically rich mixture of woodland herbs and ferns. Moss species diversity is high. The woodlands are ungrazed. The hazel is actively coppiced in places.

There is a small area of actively regenerating cut away raised bog at Ballyrorheen. It is situated approx. 5km north west of Cappamore Co. Limerick. The bog contains some wet areas with good moss (*Sphagnum*) cover. Species of particular interest include the Cranberry (*Vaccinium oxycoccos*) and the White Sedge (*Carex curta*) along with two other regionally rare mosses including *S. fimbriatum*. The site is being invaded by Birch (*Betula pubescens*) scrub woodland. Both commercial forestry and the spread of rhododendron has greatly reduced the overall value of the site.

A number of plant species that are Irish Red Data Book species occur within the site - several are protected under the Flora (Protection) Order, 1999:

- Triangular Club-rush (*Scirpus triquetrus*) - in Ireland this protected species is only found in the Shannon Estuary, where it borders creeks in the inner estuary.
- Opposite-leaved Pondweed (*Groenlandia densa*) - this protected pondweed is found in the Shannon where it passes through Limerick City.
- Meadow Barley (*Hordeum secalinum*) - this protected species is abundant in saltmarshes at Ringmoylan and Mantlehill.
- Hairy Violet (*Viola hirta*) - this protected violet occurs in the Askeaton/Foynes area.
- Golden Dock (*Rumex maritimus*) - noted as occurring in the River Fergus Estuary.

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- Bearded Stonewort (*Chara canescens*) - a brackish water specialist found in Shannon Airport lagoon.
- Convergent Stonewort (*Chara connivens*) - presence in Shannon Airport Lagoon to be confirmed.

Overall, the Shannon and Fergus Estuaries support the largest numbers of wintering waterfowl in Ireland. The highest count in 1995-96 was 51,423 while in 1994-95 it was 62,701. Species listed on Annex I of the E.U. Birds Directive which contributed to these totals include: Great Northern Diver (3; 1994/95), Whooper Swan (201; 1995/96), Pale-bellied Brent Goose (246; 1995/96), Golden Plover (11,067; 1994/95) and Bar-tailed Godwit (476; 1995/96). In the past, three separate flocks of Greenland White-fronted Goose were regularly found but none were seen in 1993/94.

Other wintering waders and wildfowl present include Greylag Goose (216; 1995/96), Shelduck (1,060; 1995/96), Wigeon (5,976; 1995/96); Teal (2,319; 1995-96); Mallard (528; 1995/96), Pintail (45; 1995/96), Shoveler (84; 1995/96), Tufted Duck (272; 1995/96), Scaup (121; 1995/96), Ringed Plover (240; 1995/96), Grey Plover (750; 1995/96), Lapwing (24,581; 1995/96), Knot (800; 1995/96), Dunlin (20,100; 1995/96), Snipe (719, 1995/96), Black-tailed Godwit (1062; 1995/96), Curlew (1504; 1995/96), Redshank (3228; 1995/96), Greenshank (36; 1995/96) and Turnstone (107; 1995/96). A number of wintering gulls are also present, including Black-headed Gull (2,216; 1995/96), Common Gull (366; 1995/96) and Lesser Black-backed Gull (100; 1994/95). This is the most important coastal site in Ireland for a number of the waders including Lapwing, Dunlin, Snipe and Redshank. It also provides an important staging ground for species such as Black-tailed Godwit and Greenshank.

A number of species listed on Annex I of the E.U. Birds Directive breed within the site. These include Peregine Falcon (2-3 pairs), Sandwich Tern (34 pairs on Rat Island, 1995), Common Tern (15 pairs: 2 on Sturamus Island and 13 on Rat Island, 1995), Chough (14-41 pairs, 1992) and Kingfisher. Other breeding birds of note include Kittiwake (690 pairs at Loop Head, 1987) and Guillemot (4010 individuals at Loop Head, 1987)

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There is a resident population of Bottle-nosed Dolphin in the Shannon Estuary consisting of at least 56-68 animals (1996). This is the only known resident population of this E.U. Habitats Directive Annex II species in Ireland. Otter, a species also listed on Annex II of this directive, is commonly found on the site.

Five species of fish listed on Annex II of the E.U. Habitats Directive are found within the site. These are Sea Lamprey (*Petromyzon marinus*), Brook Lamprey (*Lampetra planeri*), River Lamprey (*Lampetra fluviatilis*), Twaite Shad (*Allosa fallax fallax*) and Salmon (*Salmo salar*). The three lampreys and Salmon have all been observed spawning in the lower Shannon or its tributaries. The Fergus is important in its lower reaches for spring salmon while the Mulkear catchment excels as a grilse fishery though spring fish are caught on the actual Mulkear River. The Feale is important for both types. Twaite Shad is not thought to spawn within the site. There are few other river systems in Ireland which contain all three species of Lamprey.

Two additional fish of note, listed in the Irish Red Data Book, also occur, namely Smelt (*Osmerus eperlanus*) and Pollan (*Coregonus autumnalis pollan*). Only the former has been observed spawning in the Shannon.

Freshwater Pearl-mussel (*Margaritifera margaritifera*), a species listed on Annex II of the E.U. Habitats Directive, occurs abundantly in parts of the Cloon River.

There is a wide range of landuses within the site. The most common use of the terrestrial parts is grazing by cattle and some areas have been damaged through over-grazing and poaching. Much of the land adjacent to the rivers and estuaries has been improved or reclaimed and is protected by embankments (especially along the Fergus Estuary). Further, reclamation continues to pose a threat as do flood relief works (e.g. dredging of rivers). Gravel extraction poses a major threat on the Feale.

In the past, Cord-grass (*Spartina* sp.) was planted to assist in land reclamation. This has spread widely, and may oust less vigorous colonisers of mud and may also reduce the area of mudflat available to feeding birds.

Domestic and industrial wastes are discharged into the Shannon, but water quality is generally satisfactory - except in the upper estuary, reflecting the sewage load from Limerick City. Analyses for

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trace metals suggest a relatively clean estuary with no influences by industrial discharges apparent. Further industrial development along the Shannon and water polluting operations are potential threats.

Fishing is a main tourist attraction on the Shannon and there are a large number of Angler Associations, some with a number of beats. Fishing stands and styles have been erected in places. The River Feale is a designated Salmonid Water under the E.U. Freshwater Fish Directive. Other uses of the site include commercial angling, oyster farming, boating (including dolphin-watching trips) and shooting. Some of these may pose threats to the birds and dolphins through disturbance. Specific threats to the dolphins include underwater acoustic disturbance, entanglement in fishing gear and collisions with fast moving craft.

This site is of great ecological interest as it contains a high number of habitats and species listed on Annexes I and II of the E.U. Habitats Directive, including the priority habitat lagoon, the only known resident population of Bottle-nosed Dolphin in Ireland and all three Irish lamprey species. A good number of Red Data Book species are also present, perhaps most notably the thriving populations of Triangular Club-rush. A number of species listed on Annex I of the E.U. Birds Directive are also present, either wintering or breeding. Indeed, the Shannon and Fergus Estuaries form the largest estuarine complex in Ireland and support more wintering wildfowl and waders than any other site in the country. Most of the estuarine part of the site has been designated a Special Protection Area (SPA), under the E.U. Birds Directive, primarily to protect the large numbers of migratory birds present in winter.

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SECTION 4

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Archaeological Inspection, Wooden Fishtrap Structures, O'Brien's Point, River Shannon, Co. Clare.



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Report No. DB 01-09-08

Cover: Wooden Fishtraps, O'Brien's Point,
River Shannon, County Clare.

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1.0 INTRODUCTION

1.1 INTRODUCTION

Shannon Foynes Port Company commissioned *Mr Donal Boland.* to conduct an inspection of a Wooden Fishtrap Complex at O'Brien's Point, River Shannon, County Clare. (Figure 1.1).

The Fishtrap complex was first located in 1998
Report: Underwater Inspection of Three Proposed Dump Sites in the Shannon Estuary, Management for Archaeology Underwater Ltd, 1998

The Fishtrap complex was surveyed in 1999
Report: Archaeological Inspection of Wooden Structures at O'Brien's Point In the Shannon Estuary, Management for Archaeology Underwater Ltd, 1999.

The Fishtrap complex was re-assessed in 2002
Report: Archaeological Re-Assessment, Wooden Fishtrap Structures, O'Brien's Point, River Shannon, Co. Clare. BAS 01-09-02

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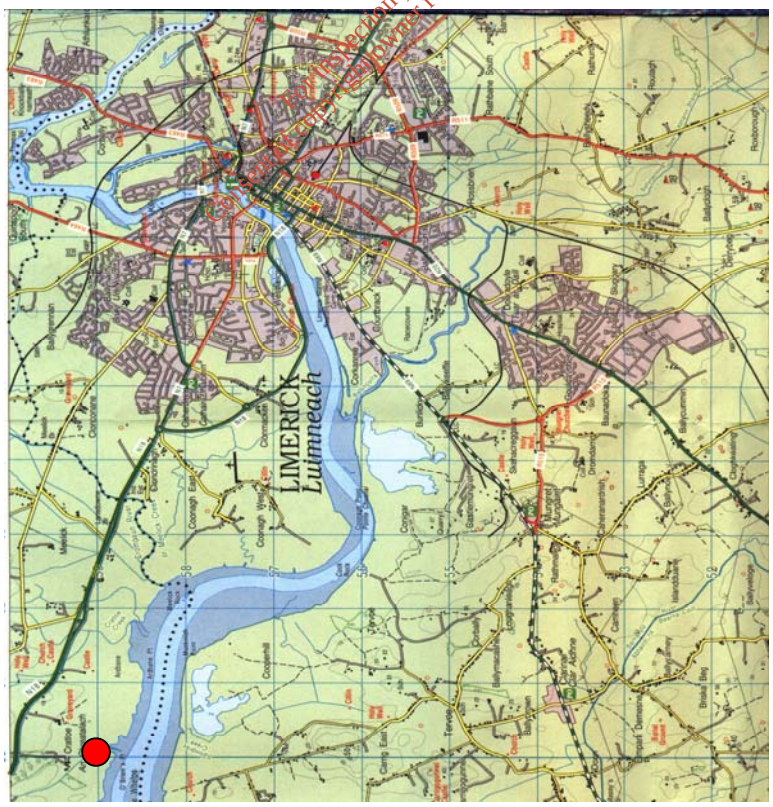
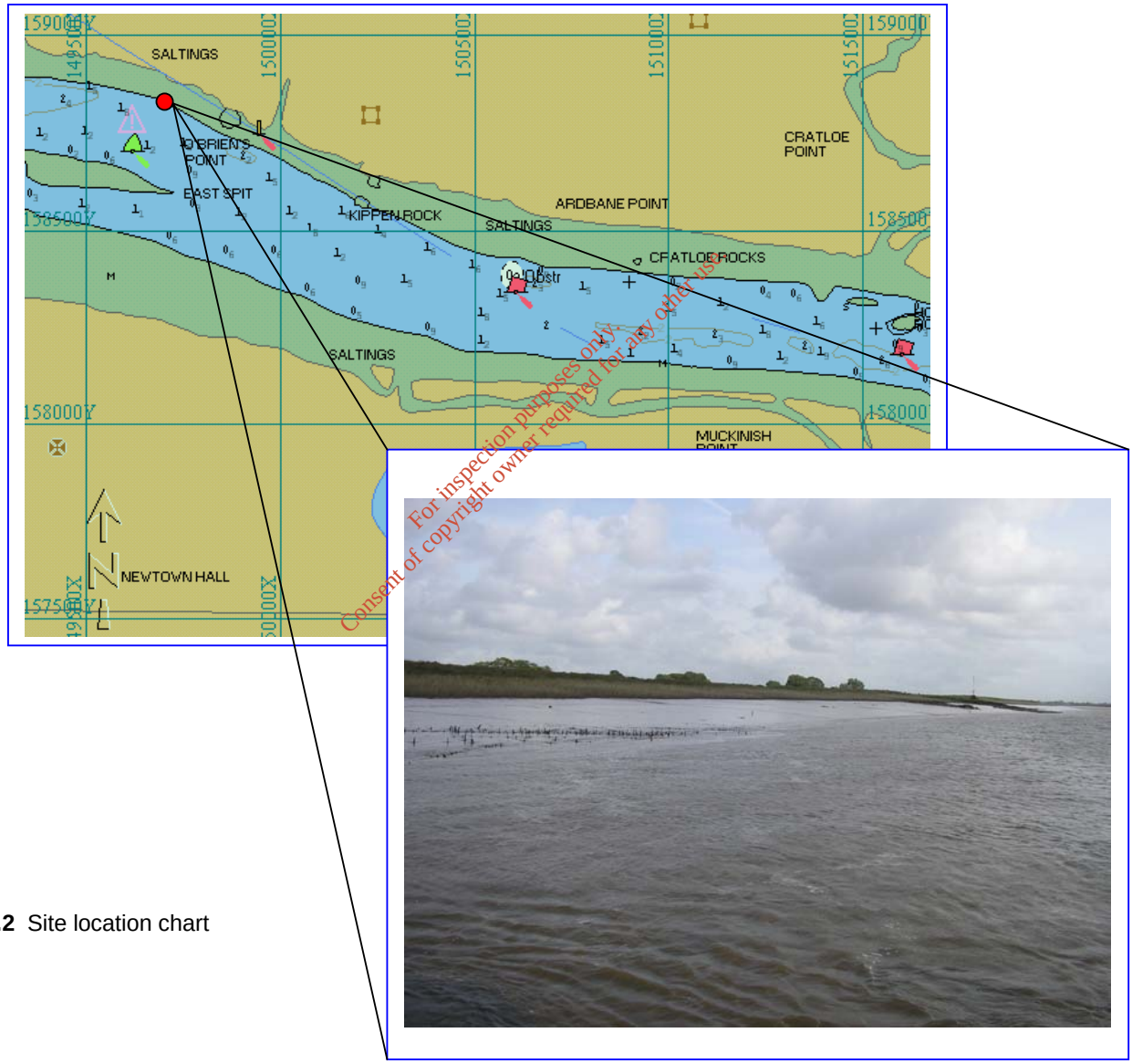


Fig 1.1 The location of the fishtrap complex, indicated by the red dot

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1.2 THE SITE

The O'Brien's Point fishtrap complex (Fig 1.2) of at least six wooden fences is situated on the north bank of the Shannon estuary, on a gently sloping foreshore of very firm grey, sandy, estuarine silts (52, 40.6829 8, 44.6154). The structures located midway between O'Brien's Point to the east and the mouth of an unnamed creek to the west are well preserved and deeply set. A Late Medieval towerhouse site at Castle Donnel is situated on the drylands to the north-east and a Post Medieval landlord house is found on the drylands to the north.



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Fig 1.2 Site location chart

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1.3 THE DEVELOPMENT

The narrow and shallow nature of the Shannon at and above Limerick coupled with the flushing effect created by the discharge of an upstream power plant creates high sediment transportation rates within the river, which abate causing siltation downstream where the river widens adjacent to Limerick docks.

Maintenance dredging of Limerick docks and its approaches has been conducted on an annual basis since 1955 to control the level of deposited silt and maintain the required depth within the navigation channel.

The Shannon Foynes Port Company has dumped approximately 30,000 tons of transient estuarine silts dredged from Limerick docks and its approaches at the dumpsite located close to the O'Briens fishtrap complex during the period 1999 to 2002.

The Shannon Foynes Port Company propose to dredge the berths at Limerick docks and the approaches to the docks during the coming years. It is proposed to dump the material dredged from Limerick at the dumpsite located on the opposite side of the river from the O'Brien's Fishtrap Complex.

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The dredging operations will be conducted by the port companies grab dredge and attending dump barges. The grab dredge is utilised to extract the transient silt material from the bed of the river and deposit it in a bottom opening dump barge. When full the dump barge travels to the dumpsite where the material is deposited in a linear stream along the riverbed.

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1.4 HISTORICAL AND ARCHAEOLOGICAL BACKGROUND

In medieval and late medieval times, headweirs were the most common type of fishweir used in Irish coastal and riverine waters. They were constructed of two post and wattle fences or 'wings' which converge to a point in a V -shape. The widest opening of these fences most commonly faced upstream or towards the shore, to funnel fish coming down on the ebbing tide into the 'eye' of the weir. At the 'eye' of the weir, fish were trapped in a 'coghill' net, which was suspended from a raised platform. These nets were conical in shape being long composite mesh bags kept open by means of attachments to the uprights of the wooden platform. More primitive forms of tidal weir (and possibly of early origin) were the 'fish pounds' or I salmon walls' in Doonbeg Bay, Co. Clare and Lough Swilly, Co. Donegal. These were formed of long, low stone walls on the sand flats. They trapped fish moving out to sea on the ebbing tide, whereupon they were taken from the remaining pools by nets.

Headweirs were typically in use in Irish tidal waters until the late nineteenth-century, with the best-known examples at Castlebellingham, Co. Louth, Bunratty, Co. Clare and Buttermilk Castle, Co. Wexford surviving up until the twentieth-century. The Buttermilk castle weir was known to produce large amounts of cod, ling, herring and salmon. However, all tidal head weirs, other than the three mentioned above were abolished by English government legislation after 1863. It was asserted that these weirs were both a hazard to navigation and ruinous to fish stocks.

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The second type of Post Medieval fishtrap recorded at O'Brien's Point is the stake-net weir. In the early nineteenth century, this different form of 'fixed engine' began to be used in competition with the earlier headweirs. They were known as stake weirs or Scotch nets because they entailed the use of walls of netting anchored by long stakes to the shore, thus diverting fish into a trap net. They were much more ruthless and efficient than head weirs and quickly replaced them in Irish estuaries and reputedly menaced fish stocks to such an extent, that successive attempts were made to restrict their use by further legislation. The stake-net weirs on the Shannon estuary consist of very lengthy post alignments, which run straight down the foreshore.

Fish weirs were also extremely common in recent times on most Irish rivers, notably the Bann, Erne, Corrib, Boyne, Blackwater, Suir and Shannon rivers. Riverine fishweirs were in contrast placed wholly or partially across the span of a river and worked on the basis of a constant flow of water in one direction. Legislation generally prevented them from being constructed entirely across the river to protect fish stocks. Thus a 'free gap' was left to let some fish move unimpeded past the weir. Depending on the type of weir, salmon and other fish were caught on their way upstream and eels were trapped while migrating downstream in

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autumn. Like the other weirs, riverine weirs were typically formed of complex post-and-wattle barriers or stone walls with several box-shaped enclosures or 'cribs' situated along its length. Fish could either be taken from the calm pools within the enclosures or 'coghill' nets were used as traps. Particularly famous were the fisheries at Galway, Athlone and Limerick. The latter was known as the Lax Weir, a name which derives from the Norse word for salmon and suggests its early origin. It is first recorded in twelfth century charters, is thereafter marked on the Down Survey maps and is recorded in the Civil Survey of 1654-6 as a 'greate salmon weare called Lax weare'. Two hundred years later in 1864, it was reported as having fifty-one stone piers, twelve boxes or cribs and a small 'free gap'. Other famous fisheries were the eelweirs at Toome, Co. Antrim, strategically placed to catch mature silver eels moving down the River Bann from Lough Neagh. These weirs consisted of a series of V -shaped wattle lanes or 'skeaghs' which guided the eels into heavy 'coghill' nets, enabling catches of up to one hundred and fifty tons a year.

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2. THE SITE SURVEY

2.1 THE SURVEY DESIGN

The site was inspected on the 29th of September by way of a non impact visual and photographic survey conducted from the multicat vessel ***Shannon 1*** provided by the Shannon Esturary Port Company. The results of the inspection were compared to the results of the re-assessment survey, conducted in 2002 and conclusions drawn (Fig 2.1).

2.2 THE SITE INSPECTION

The foreshore at and surrounding the fishtrap complex located at O'Brien's point was inspected during a period of low water on a spring tide. The overall topography of the foreshore does not appear to have changed since the date of the initial assessment undertaken in 1999 and or the re-assessment survey conducted in 2002. The wooden fishtrap structures are intact as originally surveyed and appear to have changed little in the intervening years (Fig 2.2 & 2.3).

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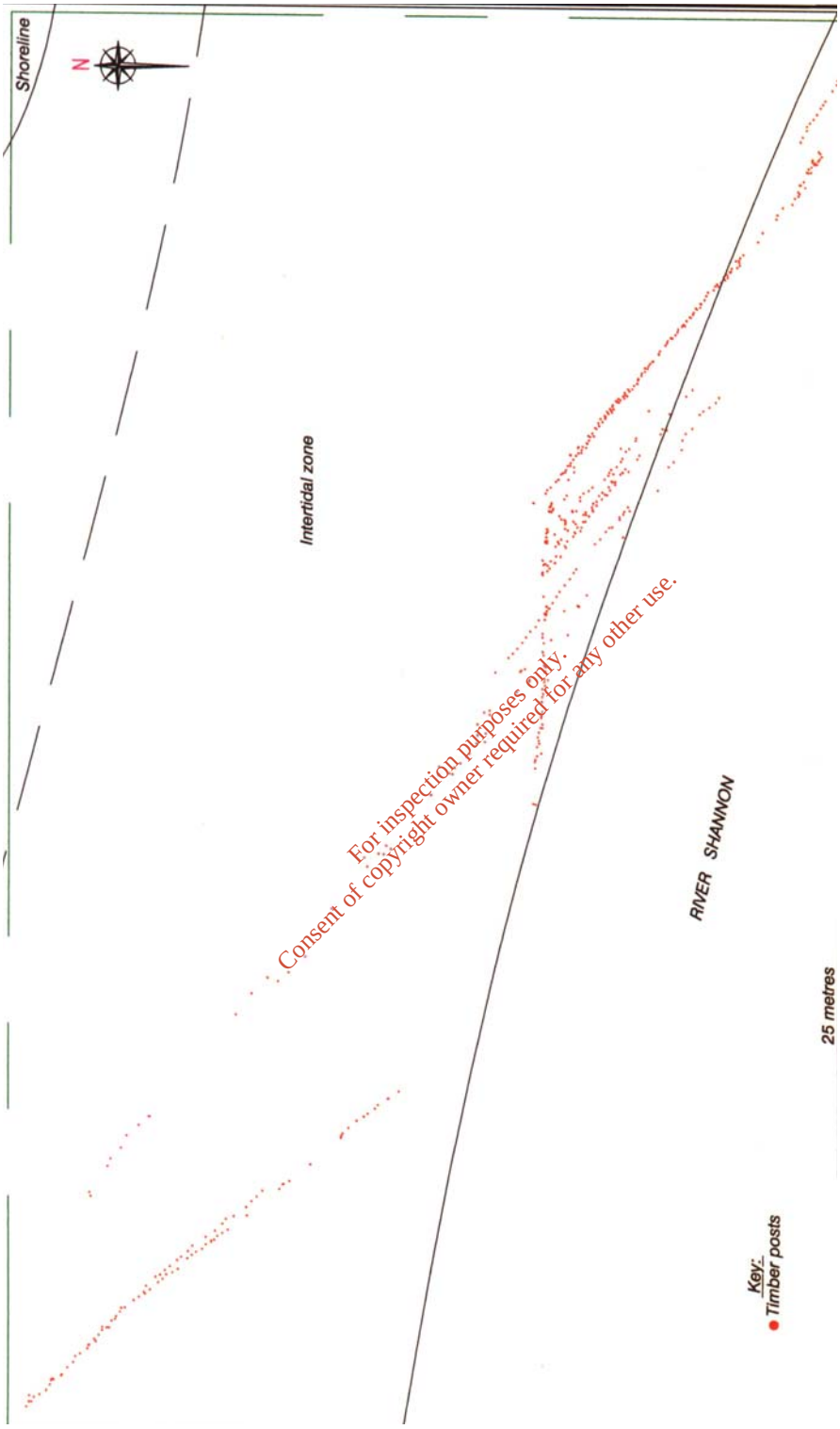
A layer of soft estuarine mud overlays firm grey, sandy, estuarine silts on the foreshore. The mud appears to be transient in nature being removed and redeposited by the forces of tide and storm. At the time of this inspection it was noted that the deposit of this soft mud had increased over the site.

Comparing the results of the original survey and the re-assessment survey with the existing site indicates that the build up of soft estuarine mud has completely covered a number of the posts along the upper to mid foreshore (fig 2.6). Small erosion pits extending only to the depth of the transient mud layer are evident surrounding the larger exposed upright posts of the lower foreshore (Fig 2.5).

Comparing the results of the photographic survey with the survey conducted in 1999 shows very little change in the foreshore area and no appreciable change to the fishtrap structures. As we are dealing with archaeology contained within an active intertidal maritime environment some change in sediment cover is normal and will increase or decrease depending on tidal and / or storm forces.

Based on the results of this and previous inspections the writer concludes that dredging and / or dumping operations being conducted by the Shannon Foynes Port Company is not having any adverse affect on the fishtrap complex situated at O'Brien's Point.

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Fig 2.1 Site as surveyed in 1999

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Fig 2.2 The site in 2002, looking downstream

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Fig 2.3 The site in 2002, looking upstream

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Fig 2.4 Small erosion pits within mud layer surrounding upright post on lower foreshore 2002

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Fig 2.5 Soft estuarine mud overlaying posts on mid / upper foreshore 2002

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Fig 2.6 Fishtrap Structures intact on mid / lower foreshore looking downstream 2002

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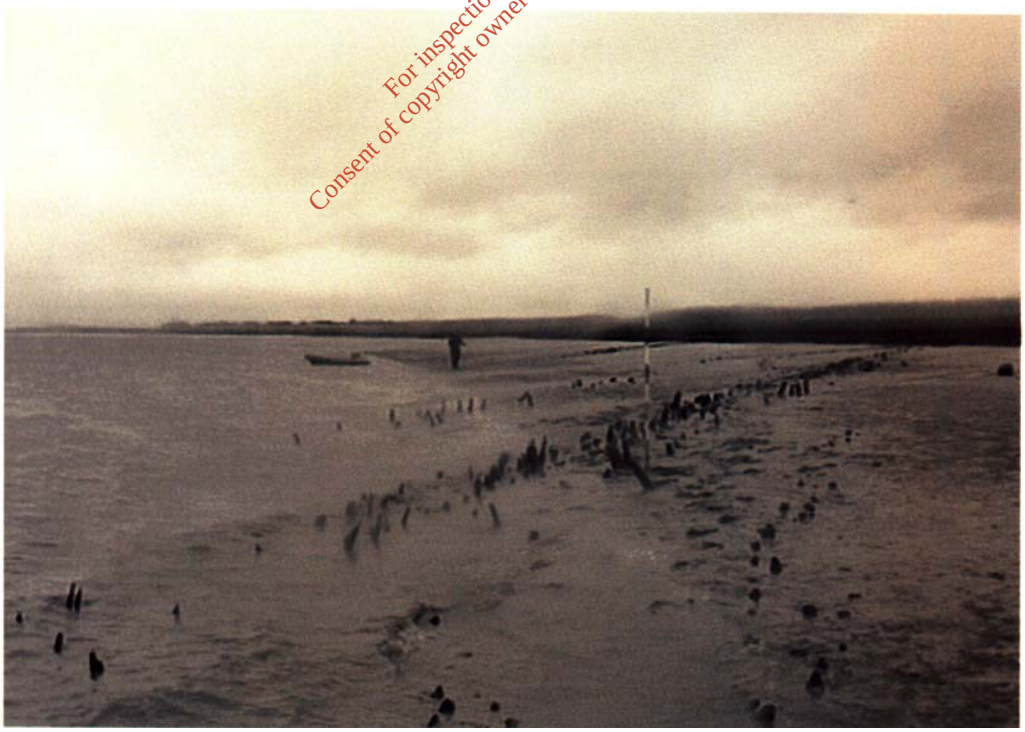


Fig 2.7 Fishtrap Structures on mid / lower foreshore in 1999 looking downstream

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Fig 2.8 Fishtrap Structures on mid / lower foreshore in 1999 looking upstream

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Fig 2.9 Fishtrap Structures intact on mid / lower foreshore looking upstream 2002

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Fig 2.10 Fishtrap Structures intact on the upper foreshore 2008, looking north

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Fig 2.11 Fishtrap Structures intact on the mid foreshore 2008, looking north east

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Fig 2.12 Fishtrap Structures intact on the mid and lower foreshore 2008, looking north.

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Fig 2.13 Fishtrap Structures intact on the lower foreshore 2008, looking north east

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Fig 2.14 Fishtrap Structures intact on the lower foreshore 2008, looking north east

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Fig 2.15 Fishtrap Structures intact on the lower foreshore 2008, looking north east

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Fig 2.16 Fishtrap Structures intact on the lower foreshore 2008, looking north

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Fig 2.17 Fishtrap Structures intact on the lower foreshore 2008, looking north

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3. IMPACTS, CONCLUSIONS, MITIGATION

3.1 IMPACTS

Estuarine silts dredged from the approaches and berths at Limerick docks will be deposited at a dump site on the opposite side of the River Shannon from a fish weir complex located at O'Brien's Point in County Clare.

3.2 CONCLUSIONS BASED ON THE ABOVE ASSESSMENTS.

- The fishtrap complex at O'Briens Point is intact as surveyed in 1999 and 2002
- A layer of transient silty estuarine mud presently overlies the firm estuarine mud comprising the foreshore at O'Briens Point.
- The transient mud is forming a protective layer above the fishtrap structures on the foreshore.
- The site exhibited no features, which could be attributed to the dumping operations other than possibly, the accumulation of a protective layer of estuarine silts.

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3.3 MITIGATION

1. The fishweir complex at O'Brien's Point to be re-assessed in 2012 if dumping operations continue at the present location until that time.

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SECTION 5

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Archaeological Assessment, Proposed Marine Dump Site, Sod Island, Shannon Estuary, Co. Limerick



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1 EXECUTIVE SUMMARY

Sod Island (1591500N, 142850E) lies in the centre of the upper Shannon Estuary. It is approximately 1km north west of Mellon Point on the Shannon's southern shore in Co. Limerick and approximately 1.3km south of Inishcullin Hill on the Estuary's northern bank in Co. Clare. The site investigated, to the south of Sod Island, is the proposed location of a dumpsite for dredged material from adjacent areas of the Shannon Estuary.

The pre-development assessment and geophysical surveys were conducted by Mr Donal Boland under guidelines and acquisition parameters as recommended by the Maritime Unit of The Department of the Environment, Heritage and Local Government Licence Number: 05R120 / 05D107.

The Shannon estuary has long been occupied and exploited by humans. Prehistoric foragers and farmers, medieval and postmedieval fishermen, mariners, farmers, landlords and labourers have worked on the land, foreshore and the waters themselves. While some of the archaeological remains from these people have been known about for a long time, others such as the numerous fishtraps were only discovered in recent years. As parts of the estuarine muds continue to be eroded more archaeological features may be revealed; likewise with the shipwreck record. There must be many more vessels lying in the estuarine muds, the place and time of loss forgotten. The potential for uncovering archaeological material in the vicinity of Sod Island is high, given the proven level of activity in the estuary in the past and the quality and frequency of archaeological remains already recorded.

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The substrate at the proposed development is characterised by low backscatter returns without texture, indicative of fine muddy seabed (Fig. 16). Little of no bedform development at the site provides further indication of this fine silty mud. Bathymetry ranges from <1m on the north-western margin of the survey area, to a maximum depth of over 6m in an isolated depression of approximately 0.4km x 0.2km to the north east. The survey zone's shallow area (<2m) extends for approximately 1km in the direction of the Estuary's South Channel.

No anomalies of archaeological potential were interpreted from the side-scan sonar survey at the site. The results of the magnetometer survey are dominated by magnetic deviation in the range of -35 to -45nT, interspersed with areas of approximately –50nT. There are nine anomalous magnetic signatures (M1-M9) in the survey data. In terms of the data range, M8 is the most significant large anomaly, with a deviation of up to –5nT and an area of approximately 1km^2. Sites M2 and M8 are the only anomalies on the fringes of the development, while the majority is clustered around the proposed site.

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It is concluded that:

- No sites of archaeological potential are interpreted from 500 kHz side-scan sonar data acquired in the survey of the proposed dump site.
- Nine magnetic anomalies are identified from the site, however only anomalies M2 and M8 are in direct association with the proposed development. With strong indications of extensive anthropogenic activity in the area, and the field of minor deviations, it is likely that the magnetic results reflect cultural debris, which has been buried by sediment accretion processes at the site.
- The proposed development is unlikely to have an adverse effect on any potential buried cultural material, as it will lie on the seabed and involves no invasive activity on the riverbed.

It is recommended that:

- The proposed marine dump site should proceed at Sod Island, River Shannon, Co. Limerick; and
- Procedures for archaeological monitoring during engineering works are not required as the development involves no dredging or invasive activity on the riverbed.

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2 INTRODUCTION

2.1 The Site

In south-west Ireland, the River Shannon and its tributaries form an extensive freshwater system that drains an areas of c. 15, 700km2 of the Irish midlands. The greater Shannon estuary comprised the tidal reaches of the lower River Shannon between Limerick City and the Atlantic and incorporates the Fergus estuary south of Clarecastle (Hickey and Healy, 2005) (Fig. 1). Its environs encompass parts of north Co. Kerry, north Co. Limerick and south Co. Clare. The geology dominates local topography, consisting of a conformable succession of Silurian rocks, upper Old Red Sandstone, Lower Carbiniferous Limestone series and Upper and Middle Carboniferous Limestone series (Hickey and Healy, 2005). These are overlain in turn by Yoredale Beds (shale series), Flagstone series (Millstone Grit) and, in some locations, Ouarternary glacial deposits and alluvium (Wheeler and Healy, 2001). Land adjacent to the estuary is generally low-lying, mostly extending from tidal High Water Mark (HWM) to 30m OD (OSI, 1974).

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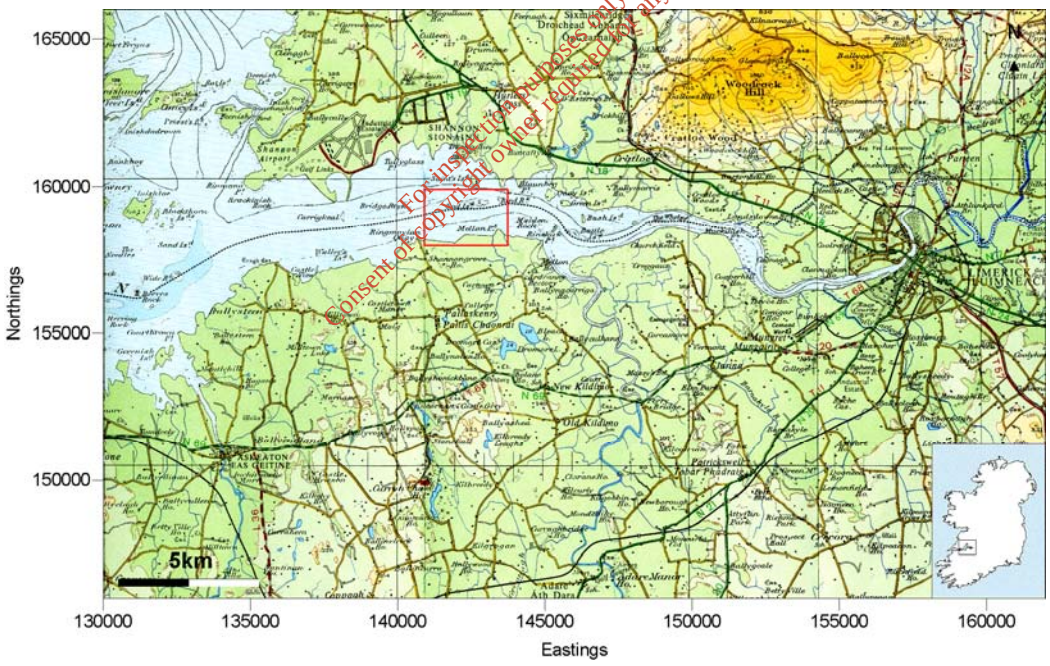


Figure 1: Locational map of Sod Island (red box), Shannon Estuary, within its national context (1/2 inch to 1 mile Map 17 – Shannon Estuary (OSI, 1986). Co-ordinates are in Irish National Grid.

The Shannon Estuary (Fig. 1) is subject to permanent marine inundation and tidal flows through a generally west-east aligned main channel measuring almost 100km from its mouth to Limerick City. The estuary is macrotidal, having the largest tidal range (5.44m at Limerick

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Docks) on the Irish Coast. Water depths vary from approximately 37m at the estuary mouth to less than 5m near Limerick City. The estuary system has extensive associated inter-tidal mudflats, fringing reed-beds, swamps, salt marshes, wet-marsh habitats and reclaimed wetlands (Hickey and Healy, 2005). The mudflats are generally unvegetated, though patches of cord grass (spartina sp.) occur in places. Healy (2002) describes the reed beds and associated habitats that typify the margins of the river and stream channels and sheltered creeks within the system. The Estuary is a candidate Special Area of Conservation (EU Habitats Directive 92/43/EEC and Natura 2000) and an existing Special Protection Area for birds (EU Birds Directive 79/409/EEC) (Hickey and Healy, 2005). The site contains several habitats and species of international importance, among which are the priority lagoon habitat, the resident population of Bottle-nosed Dolphin and all three Irish lamprey species (*petromyzon marinus, lampetra planeri, l. fluviatilis*). Several Red Data Book species are present, including triangular club-rush (*scirpus triqueter*), opposite-leafed pondweed (*groenlandida densa*), meadow barley (*hordeum secalimum*), hairy violet (*viola hirta*) and bearded stonewort (*chara canescens*) (Hickey and Healy, 2005). It is also amongst the most important sites in Europe for wintering and migrating waterfowl (Healy, 2002).

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The current ecological value of the Estuary as an important habitat is recognised nationally and internationally, but this was not always so. The estuarine environment has experienced considerable anthropogenic alteration over a very long time period stretching as far back as the Neolithic, some of which is linked to land reclamation (Wheeler and Healy, 2001; O'Sullivan, 1993 and 2001; O'Sullivan and Condit, 1995 and O'Sullivan and Daly, 1999).

Currently, the Shannon Estuary accommodates 8m tonnes of port traffic annually, particularly in coal, iron ore, oil and animal feedstuffs, making a significant contribution to international port traffic in Ireland. Shannon Estuary shipping includes large vessels, as much as 200,000 dwt, a dominance of bulk cargo and a low density of vessel numbers, about 1-2 per day (Shannon Development, 2002). In terms of industrial strengths, the Shannon estuary has several characteristics of international significance, specifically deep water adjacent to potential industrial land with low population density. Unlike established seaports, the estuary offers substantial physical capacity to accommodate maritime industrial developments. The Shannon estuary currently sustains an emerging aquaculture industry and has potential for further exploitation (Shannon Development, 2002). Therefore the modern habitat, and the environment generally, has been hybridised from elements that are both natural and anthropogenic (Hickey and Healy, 2005).

Sod Island (1591500N, 142850E) (Fig. 2), is in the centre of the upper Shannon Estuary (Fig. 1). It is approximately 0.6km north of Black Rocks (Fig. 3a), 1km north west of Mellon Point on the Shannon's southern shore in Co. Limerick, approximately 0.6km south of Saint's Island and approximately 1.3km south of Inishcullin Hill on the Shannon's northern bank in Co. Clare.

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Figure 2: Sod Island: a) view from the south and b) clastic upper foreshore and algae-vegetated lower intertidal zone.

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Figure 3: a) View of Black Rocks from the north east and b) Southern riverbank of the Shannon Estuary in Co. Limerick, viewed from the survey area to the north.

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2.2 The Development

The site investigated is the proposed location of a dumping site for dredged material from adjacent areas of the Shannon Estuary and materials from the proposed tunnel crossing, *Limerick Southern Ring Road phase 11.*

The co-ordinates of the dump site, south of Sod Island are provided in Table 1 and its location is indicated in Fig. 4.

Position	Easting	Northing	Latitude	Longitude
1	142399.614	158816.781	52.67783333	-8.852333333
2	142907.974	158903.542	52.67866667	-8.844833333
3	142939.619	158717.677	52.677	-8.844333333
4	142431.24	158630.912	52.67616667	-8.851833333

Table 1: Site Location Points in Irish National Grid. These co-ordinates are located on the area map in Fig. 4.

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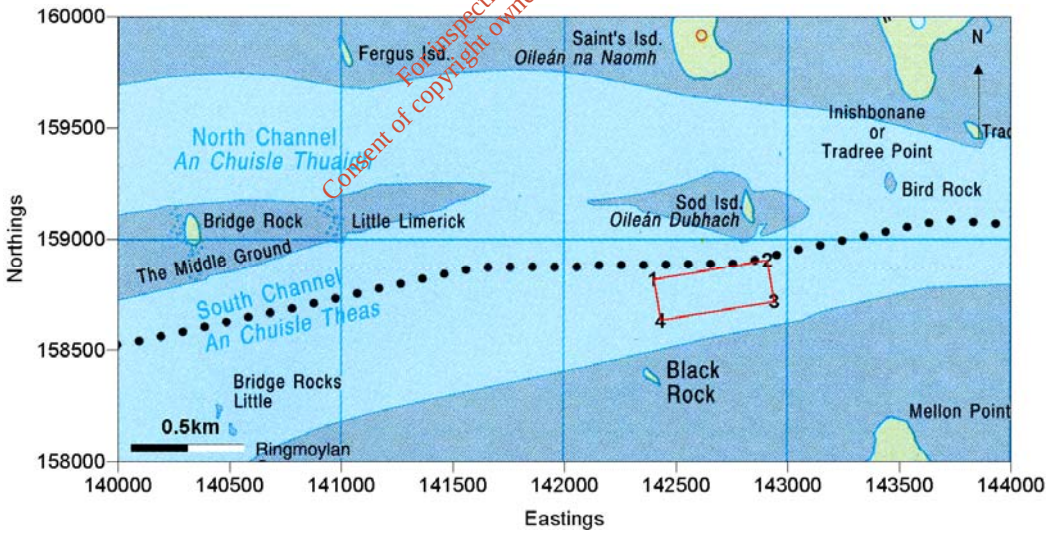


Figure 4: Location of proposed development south of Sod Island, Shannon Estuary; scale in Irish National Grid. Positional information for the site is provided in Table 1.

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2.3 The Scope of this Report

This report details and interprets the desktop and geophysical survey data recorded at the site of and adjacent to the dredging dumpsite south of Sod Island, Shannon Estuary, Co. Limerick.

The pre-development assessment and geophysical surveys were conducted by Donal Boland under guidelines and acquisition parameters as recommended by the Maritime Unit of The Department of the Environment, Heritage and Local Government.

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2.4 Data Acquisition Method

2.4.1 Data Acquisition

Geophysical surveys were conducted by Donal Boland from a local survey vessel, *Graig* (Fig. 5), at an average lane spacing of 30m. Details of the survey suite and operational parameters are provided in Sections 2.4.2-2.4.4.



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Figure 5: *Graig*, aboard which marine geophysical surveys were conducted at the Shannon Estuary development site.

2.4.2 Global Positioning System

Positional data with a quoted accuracy of 1-3m, were provided by a *DGPS MAX* series differential global positioning system with differential corrections supplied by the General Lighthouse Authority (GLA) reference station at Loop Head. Positional data were downloaded at a 1-second interval via a standard RS-232 serial port interface into *Hypack* software on a laptop platform. The WGS-84 ellipsoid was used as datum. Parameters utilised for conversion of WGS84 data to Irish Grid are detailed in Table 2.

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Parameter	Conversion factor
Semi-major Axis	6377340.189
1 / Flattening	299.324964
Latitude of Origin in Degrees	53.500000
Longitude of Origin in Degrees	-8.000000
False Easting	200000.000
False Northing	250000.000
Scale Factor	1.000035
Datum Shift DX	-482.530
Datum Shift DY	130.596
Datum Shift DZ	-564.557
Datum Shift RX	-1.042000
Datum Shift RY	-0.214000
Datum Shift RZ	-0.631000
Datum Shift Scale	8.150000

Table 2: Parameters utilised for conversion of WGS84 data to Irish Grid.

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2.4.3 Bathymetric Survey

The bathymetric survey was conducted using a single-beam echo-sounder operating at 200 kHz. Positional and bathymetric data was downloaded at 1-second intervals via an RS-232 serial port interface to a laptop. Layback corrections were not required as the DGPS antenna was mounted directly above the echo-sounder.

2.4.4. Side-Scan Sonar Survey

The side-scan sonar survey was conducted using a dual-frequency *GeoAcoustics* Model 159A side-scan sonar towfish and Model SS941 transceiver system at an operational frequency of 500kHz. Data was acquired without slant-range correction, with swath width set at 74m (37m range per channel). Trackline spacing was fixed at 30m ensuring that in excess of 200% riverbed coverage was achieved throughout the survey. Sonar data was acquired in SEG-Y format, processed in *GeoPro LC* on an Apple Macintosh platform and logged to disk.

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2.4.5. Magnetometer Survey

The magnetometer survey was conducted using an *Aquascan* AX2000 proton magnetometer linked to a *Litton Marine* LMX-400 DGPS unit. Magnetic data were acquired in XYZ Raw ascii files. Trackline spacing followed the same 30m pattern as the side-scan sonar survey, thus ensuring adequate coverage for archaeological survey as recommended by the Maritime Unit, The Department of the Environment, Heritage and Local Government

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2.5 Data Processing and Interpretation

2.5.1 GPS

The track resulting from survey of the proposed dredge dumpsite, south of Sod Island, Shannon Estuary is shown in Fig. 6.

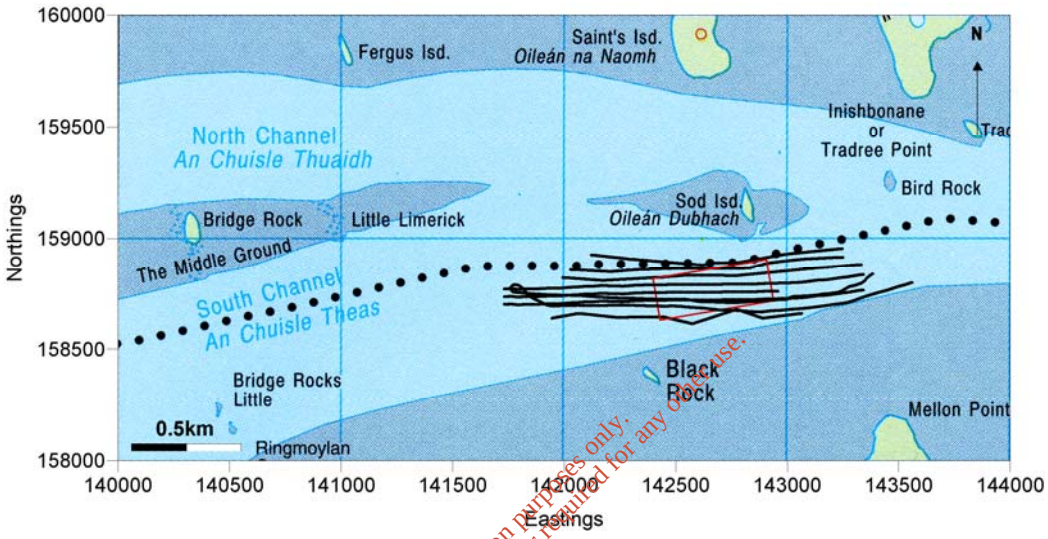


Figure 6: Track chart resulting from the site survey (Scale in Irish National Grid). The position of the proposed development is indicated by the red box.

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2.5.2 Bathymetric Survey

Bathymetric XYZ files were processed using *Surfer 8*. Raw ascii files were gridded in 2m bins using the Nearest Neighbour interpolation method. Two- and three-dimensional contour plots were produced for interpretation and data integration.

2.5.3. Side-Scan Sonar Survey

500kHz data in SEG-Y format were examined for each survey line. Sonar data was processed in *GeoPro LC* on an Apple Macintosh platform. Images were extracted as GeoTIFF files for inclusion in this report.

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2.5.4. Magnetometer Survey

Magnetometer data were processed using *Surfer 8*, gridded in 10m bins using the Nearest Neighbour interpolation method. Two- and three-dimensional contour plots were filtered and examined for anomalies.

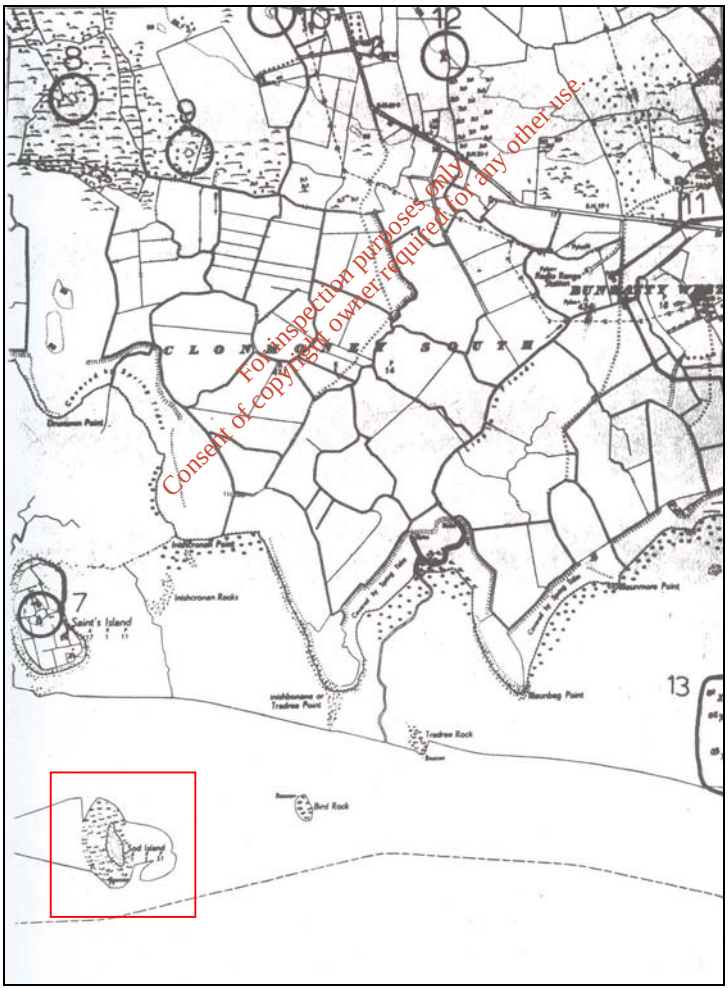
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3.1 Desktop Survey

3.1.1 Introduction and Landscape

Sod Island forms part of what is known as the middle ground in the upper Shannon Estuary (Fig. 7). County Clare lies to the north and county Limerick to the south. In the past, before relatively modern reclamation works, the upper Shannon estuary would have flowed through a range of features such as estuarine and freshwater wetlands, with mudflats, saltmarshes, reed-swamps, fens and bogs, giving way further inland to a scrubby, wet cover of carr woodland. The surrounding drumlin hills and upland terraces on both sides of the estuary would have been the main focus for rural settlements, agriculture and woodlands.



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Figure 7: Co. Clare OS 6" Sheet 61 showing the location of Sod Island in the Upper Shannon Estuary.

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3.1.2 Archaeological and Historical Background

Sod Island is situated on the main water-way to the city of Limerick and is very close to the historical town of Bunratty. This is an area very rich in archaeological material. Recent surveys carried out by O'Sullivan (2001) on the Shannon estuary region has revealed a number of previously unrecorded archaeological sites, mostly in the form of wooden fishtraps. His survey covered the inter-tidal area from Limerick to the Maigue estuary on the south bank and from Limerick to Saint Island on the north bank. This means that the inter-tidal zone to the south of Sod Island was not intensively examined in this survey. A rapid survey was also carried out from Saint's Island to Rineanna (Shannon Airport). This work has greatly increased our knowledge of this area and how estuarine resources were exploited. It appears that rather than being a marginal and inhospitable area, the estuary was an important trade route to Limerick and provided a good source of fish.

Some of the archaeological sites discussed here may be up to 6km from Sod Island but the range of multiperiod archaeological and paleo-environmental deposits found there are important in demonstrating the level of activity in the past in the estuary and the potential for archaeological remains. Also, seeming as the foreshore to the south of Sod Island was not included in O'Sullivan's Shannon Estuary survey, there is a high potential for the existence of archaeological remains in the area that have not yet been recorded.

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Mesolithic Period (7000-4000 BC)

The earliest inhabitants of the Shannon estuary area date to the Mesolithic period. While a number of Mesolithic sites have been found in Limerick, little evidence of Mesolithic activity has been identified along the Shannon estuary yet. Even so, it is thought that due to the plentiful wetland and riverine resources of the estuary, it would have been a very attractive place for the hunter-gatherer lifestyle of the Mesolithic people, which involved hunting, fishing and the collecting of plant foods. A Late Mesolithic wooden plank, measuring 4.3m long, was found Carrigdirty Rock 8, located on the upstream south bank (Fig. 8, Fig. 9). It is uncertain what this plank was. Initially it was thought to be part of a dugout boat but the lack of evidence of wood-working has raised suggestions that it is natural in origin. At Carrigdirty Rock 11 there is a 2m long scatter of brushwood along a clay shelf. Again it is uncertain whether this is a natural feature or formed part of a trackway or platform.

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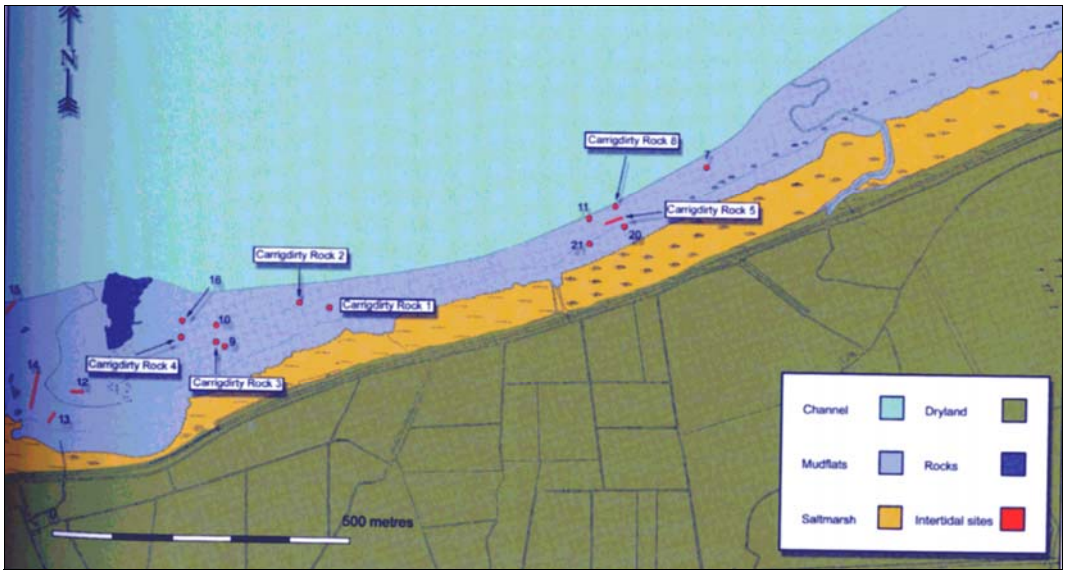


Figure 8:Location of Intertidal Sites at CarrigdirtyRock (O'Sullivan, 2001).

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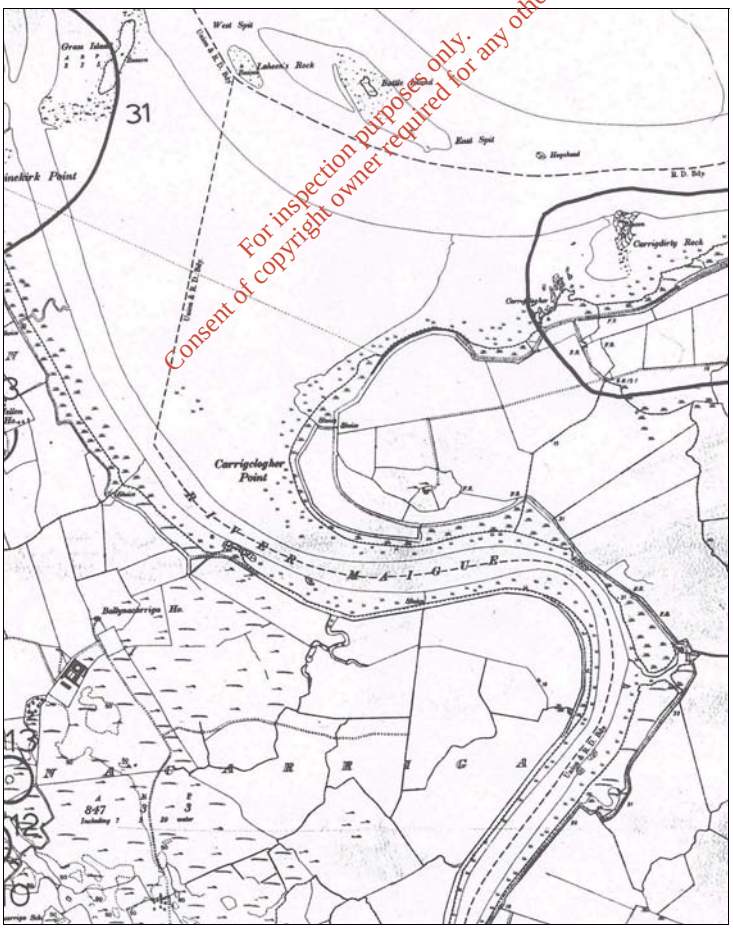


Figure 9: Co. Limerick OS 6" Sheet 4 showing the location of Carrigdirty Rock.

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Neolithic Period (4000-2500 BC)

Farming, which was an important feature of the Neolithic, may have been introduced to the area by small groups of people coming into the region or the native hunter-gathers may have developed towards their own Neolithic lifestyle. These early farmers probably combined cattle-herding, crop cultivation and the use of fixed dwellings with some seasonal movement, incorporating hunting and gathering activities.

Mesolithic, Neolithic and Bronze Age submerged forests are common features of intertidal peat deposits around the Irish coast. Submerged forests dating to the Late Neolithic or Bronze Age have been identified at in the vicinity of Sod Island, at Carrigdirty Rock 16, Co. Limerick (Fig. 8 and 9), and possibly at Bunratty 5, Co. Clare. Carrigdirty Rock is a low, natural bedrock outcrop on the intertidal zone on the south bank of the Shannon estuary, 2km east of the River Maigue. A range of multiperiod archaeological and paleo-environmental deposits can be found there.

Carrigdirty Rock 5, located some 6-7m to the south of Carrigdirty Rock 8, contains a scatter of lithic and organic artefacts and animal bone. Finds at the site include worked wood, charcoal, hazelnuts, a stone axe, woven basketry, human bone and swan and young cattle bone. This site is thought to be evidence for a Neolithic short-stay cattle-grazing site, perhaps also associated with hunting, fishing and wild-fowling in the late summer of early autumn. The presence of human bone fragments may also suggest some other symbolic activity at the site. It was probably occupied by a small group of people who only stayed there for a few days at a time.

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Bronze Age Period (2500-600BC)

By the Bronze Age, the upper Shannon estuary may have had a range of estuarine landscapes, with saltmarshes, mudflats and tidal creeks in some areas, while elsewhere, such as at Carrigdirty Rock, there were carr woodlands, sedge fens and perhaps raised bogs. A range of possible Bronze Age sites was recorded at Carrigdirty Rock (Fig. 8 and 9). Carrigdirty Rock 1 is a Middle Bronze Age house site consisting of at least 23 vertical roundwood post, spread out over an area measuring 6.2m by 6m. There were also at least seven larger posts. These are thought to represent either the main features in a small 'bender' hut or the internal roof supports of a larger oval or circular structure. The limestone slabs found to the north-east of the structure may have been used as hearthstones or as post-pads for larger roof timbers. There were two concentrations of dense fen-wood tree roots in the peat.

There are other sites, possibly from the same period, at Carrigdirty Rock 2, 3 and 4. Carrigdirty Rock 2 consists of a cluster of vertical posts, limestone slabs and a spread of animal bone in the peat. Carrigdirty Rock 3 consists of a shallow, 0.90m long, pit cut into

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woody peat. It contained a shell-rich clay and disarticulated bone and antler of red deer and pink-footed goose, but these did not show any evidence of butchering or working. This has been interpreted as a pit for storing food or for as a place for refuse. It has also been suggested that this may have been a place for the ritual deposition of animal bones. It may be contemporary with Carrigdirty Rock 1 but its higher location of the foreshore may suggest a slightly later date, such as the Late Bronze Age or Iron Age.

Carrigdirty Rock 4 consists of two roundwood posts and one cleft post set at varying angles in the peats. These may be the remains of a small structure built with sturdy posts, sharpened using both an axe and cleaving techniques. It has been interpreted as a Late Neolithic or Bronze Age wildfowling structure or the remains of a small shelter or windbreak.

Carrigdirty Rock 20 consists of a wooden plank measuring 3.4m long, 5cm thick and an average of 50cm wide. Carrigdirty Rock 21, another plank, is situated 30m further to the west. It was 5.6m long, a maximum of 76cm wide and 2 to 5.5cm thick. The date and function of these planks are not known but their location in the peats, suggest a Middle Bronze Age date.

All of these Carrigdirty Rock sites are firmly embedded in organic-rich peats, with well-preserved remains of reeds, sedges, roots, and trunks and branches of shrubby trees. This suggests a freshwater environment containing possibly fen, carr woodland or a high saltmarsh. It is unclear whether or not the sites are contemporary.

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Early Historic (400-1100AD)

In the early historic period the upper Shannon estuary probably appeared somewhat similar to what it does today. The sea levels were the same and the estuary channel flowed through mostly saltmarshes and mudflats, with the islands on the estuary being mostly cut off at low tide. The reclamation banks had not yet been constructed though, so there would have been extensive areas of waterlogged marshes and corcass. This corcass would have been used for grazing cattle, sheep and horses. The estuary would have been used by various types of vessels, from small dug-out boats and coracles to large ships trading in the port of Limerick and the smaller ports of Bunratty, Askeaton and Ennis.

There is much evidence for settlement around Sod Island in the early historic period. These can be seen on the land fringing the estuary such as early historic ringforts, churches and monastic sites, which could be found on the surrounding mainland and islands. There are a considerable amount of archaeological sites classified as enclosures and ringforts in the surrounding land. Ringforts would have been the main occupation sites of the Iron Age, acting as enclosed farmsteads, where a farmer, his family and possibly some of his animals lived. It is known that ringforts continued to be inhabited and constructed throughout the early historic

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period and even in some cases up until medieval times. An example of such is located north of Sod Island at Clonmoney West (CL061-009; Fig. 7).

Enclosures are less definite monuments. They could be damaged ringforts or they could be all that remains of early monastic enclosures. Examples of these include LI003-024 to the south of Sod Island in the townland of Ballydoole (Fig. 10), LI004-002 to the south-east at Cartown (Fig. 11) and CL061-007, directly north in the centre of Saint's Island (Fig. 7). Given the name of this latter island, this enclosure may hold the remains of an early monastic site. There is also a stone wall running across the inter-tidal area between Saint's Island and Inishcronan Point (Fig. 12). It is some 370m long and forms a large V-shape. It is not marked on the 1st edition OS map but is marked on the 2nd edition and on the Admiralty Chart. The date and function of this feature is unknown but it may represent a causeway to the island, a failed mudflat reclamation feature, a fishtrap or a tidal mill. Historic sources also suggest that there was a Viking settlement at Bunratty in the 10th century. Of course, the Hiberno-Norse City of Limerick, which was very important in the 10th and 11th centuries, was upstream of Sod Island.

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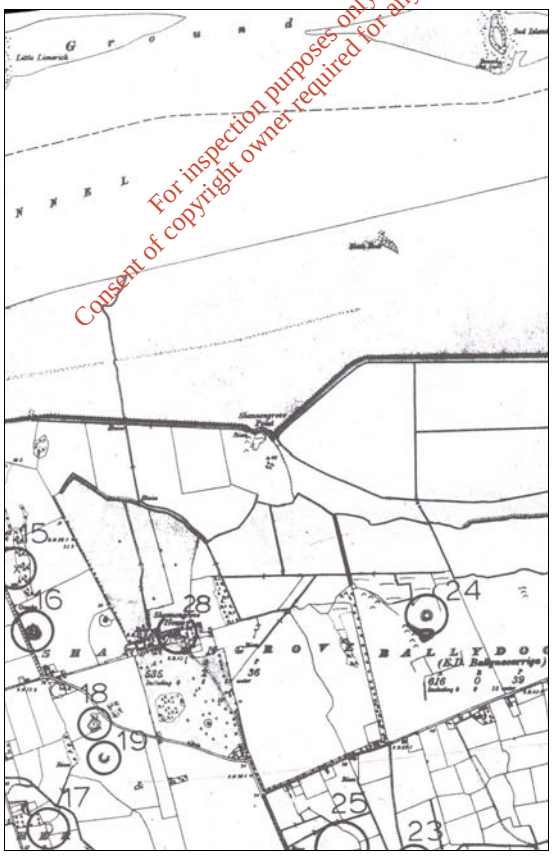


Figure 10: Co. Limerick OS 6" Sheet 3 showing the location of the townland of Ballydoole.

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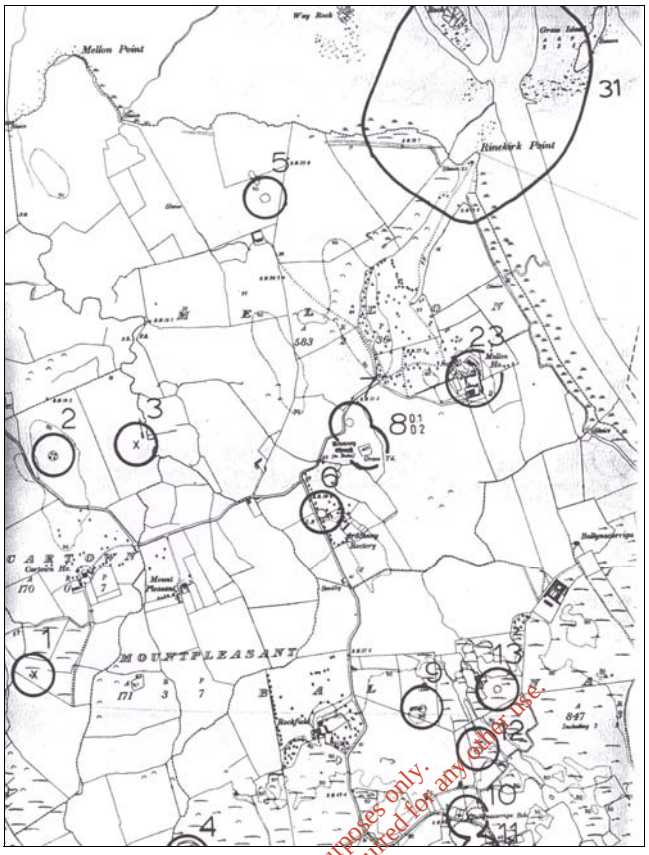


Figure 11: Co. Limerick OS 6" Sheet 4 showing the location of the townland of Ballydoole.

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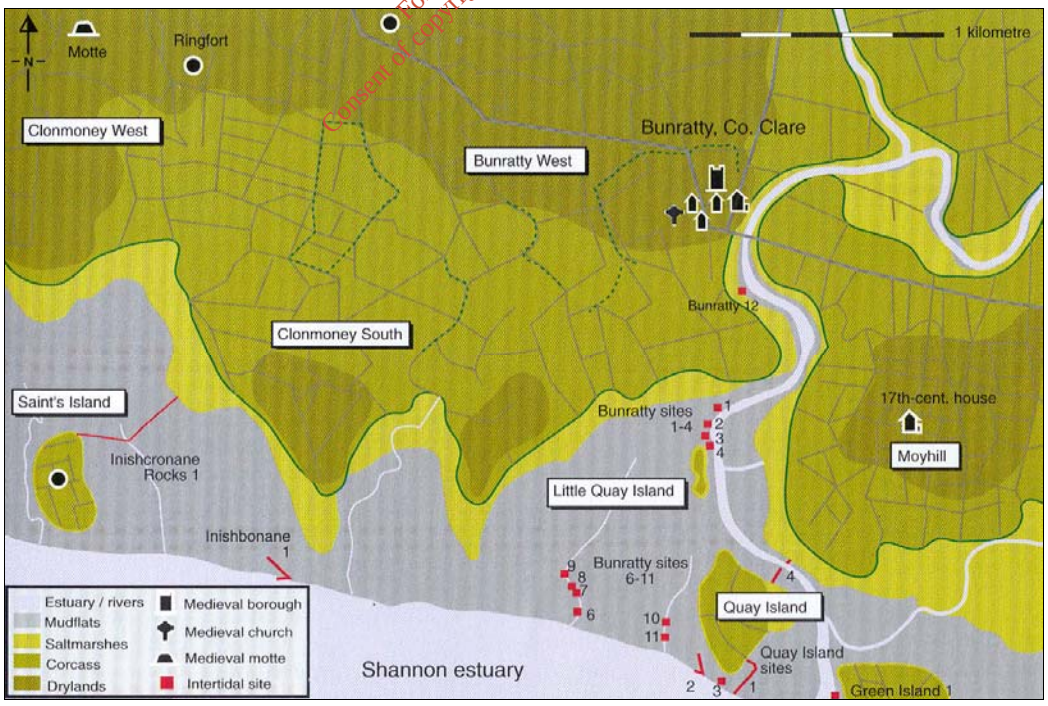


Figure 12: Location of intertidal sites in the vicinity of Bunratty, Co. Clare (O'Sullivan, 2001).

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Medieval Period (1100-1350AD)

The earliest evidence for Anglo-Norman settlement at Bunratty is found in the form of a motte-and-bailey at Clonmoney West (CL061-008; Fig. 7), possibly relating to the granting of territories at Traddery to Arnold Keating in 1199. A motte castle was a fortification built on an artificial mound, overlooking the enclosed courtyard or bailey, below. In this case the motte-and-bailey overlooks the Shannon estuary and consists of a circular, flat-topped mound with an adjoining triangular bailey. However the Anglo-Norman manor of Bunratty was first established in earnest in 1248, with the granting of the cantred of Tranderry to Robert de Muscegros. By 1251 a possible castle or motte-and-bailey was under construction to the north of the later O'Brien castle (Fig. 10). The borough may have been surrounded by an earthen bank and ditch, a feature that is described in the *Caithreim Thoirdhealbhaigh* as 'broad-based, high-crested ramparts, running from the stream to the sea'. Westropp described the presence of earthen ramparts around Bunratty, but more recent excavations have cast doubt upon their early date. It is possible that these earthen banks are the remains of 17th century reclamation features.

By 1253 de Muscegros was allowed to have a 'vill', with a weekly market and yearly fair, in his land at Bunratty. In 1277 Bunratty passed to Thomas de Clare, who built a stone castle and populated it with English tenants. During the remainder of the 13th century the castle was unsuccessfully attacked by the Irish many times. Following the defeat of the Anglo-Normans and the death of de Clare in 1318 at the Battle of Dysart O'Dea the castle and town were burnt by his widow. Bunratty was then granted to James Bellafago, but in 1325 and 1331 it was seized by followers of the Earl of Desmond. In 1332 the castle was taken and destroyed by Desmond's ally, King Muirchertertach O' Brien of Thomond. The English Justiciar, Sir Thomas de Rokeby, built a new castle there in 1353. Two years later, the castle was captured by Murchadh O'Brien, and from that date until the 17th century the castle remained in Irish hands.

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The Anglo-Norman borough of Bunratty was one of the most important medieval settlements and ports in the region at that time. By the 13th and 14th centuries Anglo-Norman and Gaelic Irish hall-houses, castles and fortresses were being built along the banks of the estuary. Medieval churches and abbeys were also established along the estuary. By 1287 Bunratty had a substantial population, a harbour, a castle, a church, markets, watermill, a fish-pond and a rabbit warren. The Anglo-Norman manor also probably consisted of arable fields closer to the town and cattle pasture on the corcass down nearer the estuary, including three islands in the estuary. Local fishermen would have worked along the foreshore, collecting fish from the numerous wooden fishtraps, and carrying out any necessary repairs. Local Gaelic Irish lords and their tenants also appeared to have been exploiting the fisheries prior to the Anglo-Norman colonisation, catering for local and more urban needs. These local fishermen may

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have continued to work the traps as free tenants on the Anglo-Norman manors and estates in the 13th and 14th centuries, when the fisheries became a highly prized and guarded resource.

By the 15th century, tower-houses owned by the Desmond lords and the O'Briens and MacNamaras of Thomond were located along the upper Shannon estuary, one of which was at Bunratty (CL062-001) and another possible castle (LI004-023; Fig. 11) at Mellon House, directly across the estuary. Bunratty Castle was built in 1425 by the MacNamaras but possession passed to the O'Briens, who were the Earl of Thomand, during the following century. The castles acted as visible statements of power and wealth on what was a significant routeway, and their landing places would have been used by boats and ships, with their fisheries also a valued resource. In 1642 and again in 1645, Brian, the Sixth earl of Thomond, handed the castle over to the Parliamentarians. The castle was soon blockaded by a Confederate force under Lord Muskerry, who forced its surrender after some two months. All that remains are fragments of the curtain and the large, rectangular keep of three storeys with four complex angle turrets. The original entrance, in the north face, leads to a vaulted hall. Beneath the hall is a vaulted cellar, while above it is an upper hall with evidence of 16th century stucco. It remained in the possession of the Earl of Thomond until 1712.

The communities along the estuary were building and using wooden fishtraps to provide fish for local consumption and for trading at market. Archaeological surveys of the Shannon estuary by O'Sullivan discovered a large number wooden fishtraps. Fishtraps are artificial barriers of wood or stone erected in rivers or estuaries to deflect fish into an opening where they can be trapped in nets or baskets. They most often take the form of head weirs, being V-shaped structures of converging vertical post-and-wattle fences or stone walls, forming a small gap, which is usually blocked by a wicker basket (Fig. 13).

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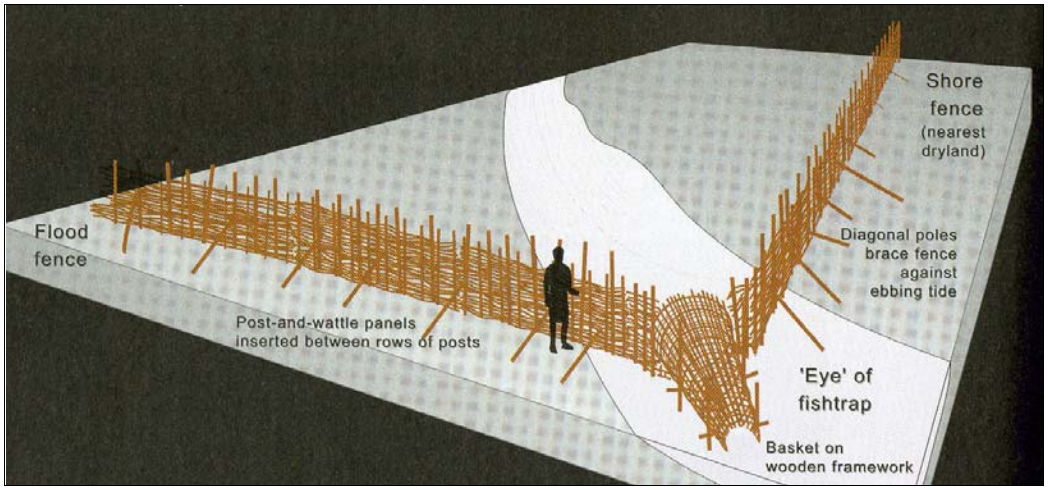


Figure 13: Reconstruction of a Medieval fishtrap (O'Sullivan, 2001).

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Depending on their orientation, they caught fish, such as salmon, moving upstream to the headwaters in spring or caught eels moving downstream in the autumn. In coastal and estuarine waters fish tend to move up the shore with the flooding tide and back down again with the ebbing tide. This means that fishtraps in these areas can be built to catch fish moving either up or down with the tide. Many examples of medieval fishtraps were found adjacent to the townland of Bunratty West (Fig. 12). At this point the estuary is quite broad, with extensive mudflats, rock outcrops and islands on both banks. The Owenagarney River flows into the estuary on the north bank. There are several former islands that are now hills in the reclaimed corcass. The medieval fishtraps are located in two clusters, Bunratty 1-4 (CL061-031) and Bunratty 6-11 (CL061-013). Bunratty 1-4 are located on the east bank of the River Owenagarney, just north-east of Little Quay Island. A submerged peat shelf, Bunratty 5, probably of pre-historic date, is also located here.

Bunratty 1 consists of a number of features exposed during low water. These include a vertical post and wattle fence, a horizontal post and wattle panel and several other vertical posts and horizontal pieces of roundwood further to the south-east. These are thought to represent two converging fences of a small V-shaped fish trap. The trapping mechanism would have been some distance further to the south-east. This structure is thought to be early historic or medieval in date. Bunratty 2 consists of a single post-and-wattle fence, orientated east-north-east/west-south-west, at a 90° angle to the modern channel. The exposed section measures 4m in length. There are no interwoven branches on the lower part of the foreshore, where intertidal and channel erosion has exposed several of these posts right down to their sharpened tips. This is thought to indicate that the structure was formerly used on a foreshore that was slightly higher and more level that that of today. The structure has been interpreted as a single post-and-wattle fence, possibly with a basket at its end. It may also have held netting, thereby being a net weir rather than a head weir. It probably dates from the late medieval period, although the density and state of preservation may indicate a late or even post medieval date.

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Bunratty 3 consists of a single post alignment and two baskets, located on the west-bank of the River Owenagarney, around 60m north-north-east of Quay Island. There is a rock outcrop or a ballast dump immediately to the south-west. The two baskets are on the extreme lower foreshore and therefore are only visible during extremely low tides. It appears to be a fishtrap, consisting of a single vertical fence, leading down to horizontal baskets. The baskets may have been just anchored in place in the creek bed or may have been pinned down with a few posts, such as those found beside one of the baskets. The baskets would have been portable traps that could be left in creeks, streams or artificial mill-streams. This site is thought to be Medieval in date.

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Bunratty 4 appears to consist of at least four phases of activity, representing two styles of fishtrap. The earliest fishtrap was probably a simple V-shaped structure. The second, third and fourth phases of activity involved a more complex V-shaped fishtrap. In its final phase the fishtrap appeared as a small V-shaped structure of two converging post-and-wattle fences, with a rectangular space defined at the apex by two parallel rows of vertical posts. A net or basket may have been placed within this area. The two baskets to the north at Bunratty 3 may have been used in this structure.


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Figure 14: Aerial photograph of Bunratty Castle on the Owenagarney River, Co. Clare (O'Sullivan, 2001).

Bunratty 6-11 (CL061-013; Fig. 14) are located closer to the main channel of the estuary, on the mudflats of a large creek that drains the foreshore between Quay Island and Illaunbeg Point. Bunratty 6 is being exposed due to erosion of the sides of the modern creek that flows in a south-easterly direction across the mudflats. This site consists of a very well preserved medieval fishtrap, with a post-and-wattle fence leading to a large woven horizontal basket. It has been radiocarbon dated to 820±35BP (cal. AD 1164-1279). The fishtrap could not catch fish in its present day location but there is evidence to suggest that it originally functioned in the bed of a now buried paleochannel. The modern creek is cutting across and exposing this ancient silted-up channel, which probably flowed in a north-east/south-west direction. The

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Bunratty 6 fishtrap was probably V-shaped, with two converging fences, perhaps up to 20m in length, leading towards a woven basket on a platform. It was an ebb weir, made to catch eels and other fish on an ebbing tide. The single exposed fence was at least 10m long and was constructed of two rows of vertical roundwood posts, against which were placed several post-and-wattle panels. Brushwood and interwoven rods may also have been laid in the gap between the inner and outer rows of posts.

The post-and-wattle fence at this site is thought to have stood to a height of 1.5-2m. Posts driven into the clays immediately upstream of the fence also helped to keep it upright in the tides. There is evidence of a possible repair at the middle, where there is a dense concentration of vertical posts, a post-and-wattle panel placed on its end and some possible bracing posts. The basket was at least 4.1m long and 0.70m in diameter and was supported by a wooden framework. It may have had a second, portable basket placed at its end. O'Sullivan has suggested that the very good state of preservation may be due to it being covered by heavy clays and silts during a sudden flood.

The 11th to 13th century fishtraps of Bunratty 4 and Bunratty 6 are important archaeological evidence for earlier medieval activity in the vicinity of Bunratty. They provide new insights into this medieval landscape, in terms of woodland management, the consumption of fish by the local population and the economic exploitation of the estuary itself. The medieval fisheries on the Shannon estuary mudflats were probably an important source of revenue, providing salmon, eels and trout for the borough's markets and households. The Bunratty 4 site has been radiocarbon dated to 1018-1159 which was well before Anglo-Norman activity in the area. This may indicate that some settlement was present at Bunratty in the 11th or 12th century but it is unknown whether this was a native Irish settlement or an outlying settlement associated with Hiberno-Norse Limerick.

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Fishing, in the Middle Ages, was an important source of food, livelihood and income in coastal and riverine area, and the ownership, regulation and use of fisheries was a key aspect of the organisation of local society and economy. Fish and shellfish were important elements in the medieval diet. Fresh and salt-water fish were caught for local consumption and were also preserved and transported elsewhere. In the early Middle Ages fishing would have been carried out on a subsistence basis only but by the later Middle Ages, with the development of urban markets, better methods of preservation and the development of Atlantic sea fisheries, fishing was potentially a great source of wealth and power.

Bunratty was also a significant medieval port or harbour, situated as it was on a low ridge overlooking a crossing-point of the river, near the mouth of the Bun Ráite or Owenagarney River, with extensive views to the south over the Shannon estuary. Bunratty was described in the 14th century as being of 'wide roads, oared galleys and safe harbour'. There may also

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have been a plank bridge across the river. A bridge is known to have been there during Toirdhealbhach Ó Briain's siege of Bunratty. It spanned the sea-channel to the opposite shore, thereby preventing ships from gaining access to the castle. Bunratty Castle remained a significant fortification throughout the late Middle Ages, being in Irish hands throughout the 15th century.

Post-Medieval Period (1534-1700AD)

During the post-medieval period, the Shannon estuary's fisheries, seaweed, oysters, reed-beds, saltmarshes and other resources were all being increasingly exploited. During the 17th, 18th and 19th centuries fishtraps of increasingly ambitious design and size were being constructed and used in places around Sod Island such as Inishbonane, Quay Island, Maiden Rock and Carrigdirty Rock. Some of these date from the 17th century while others are of 18th or early 19th origin. These fishtraps were mostly controlled by local landlords and were a source of local friction and class division.

By the 17th century the landscape around the Shannon estuary was being transformed by wetland reclamation projects but most schemes were probably carried out in the 18th and 19th centuries. Over the years, a series of earthen and stone sea-banks gradually pushed towards the estuary. Drainage ditches and field systems were then built to drain and retain the corcass, thereby creating large areas of low-lying alluvial levels now found on both the Clare and Limerick coastlines. Many of the earthworks, low banks and substantial walls visible today in the corcass may be former reclamation banks, such as the unusual rectilinear enclosure at Clonmaney West, north of Sod Island. While much time, money and effort was invested in these defences, the rewards were great. These areas of reclaimed land were used to grow wheat, barley, oats, coleseed and hay, as well as for pasture for cattle, with yields described as 'extraordinary'.

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In 1646 the English garrison at Bunratty castle surrendered. It had been surrounded by earthwork defences, including a fort. Bunratty was of great strategic importance, controlling the Shannon estuary. Artillery was able to command the navigation channel and the garrison was supported by warships of the English parliament. Bunratty was then the seat of Barnaby O'Brien, the Sixth Earl of Thomand, who was said to be a Royalist and Irish rebel all at once. Those who had retained their estates at the Restoration in 1660 appeared to be able to change allegiance at appropriate time. The remains of a post-medieval stone quay are visible running under the foundation of the old stone bridge, which crosses the Owenagarney River (Fig. 12). It is built of large flat stones laid horizontally, and stands to a height of over 1m in places. This structure may constitute part of the medieval waterfront or may represent a later structure that follows the line of an earlier quay. A post-medieval slipway is also situated on the mudflats to the south, consisting of flat, angular stones, running down to the low water mark. This was probably used to haul small boats above the high-water mark and ashore. In

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the 18th and 19th centuries, small scale fishing and some transportation operated out of Bunratty, aided by the construction of a 'new quay' in the middle of the 19th century. The Shannon estuary continued to act as a major nautical routeway during the post-medieval period, providing access to the growing port of Limerick

Fishtraps continued to be used during the post-medieval period. An example can be found north-east of Sod Island at Inishbonane, adjacent to the townland of Clonmoney South (Fig. 10). Inishbonane or Tradree Point, as it is also known, is a prominent headland that is only fully exposed during spring low tides. Inishbonane 1 is a large head weir, with its mouth orientated down stream in order to catch fish such as salmon moving up the channel with the flooding tide. A wooden platform or perch may have been used at the eye for hanging a net. The good state of preservation has suggested an 18th or 19th century date but it may be on the site of an earlier weir as there are references dating to 1703 refer to a salmon-weir at 'Clonmunny farm'.

Another post-medieval fishtrap can be found further east, near Quay Island, just west of where the Owenagarney River joins the Shannon estuary (Fig. 12). In fact there are a number of post-medieval intertidal features around this island, such as two wooden jetties or piers and a stone built causeway leading to Moyhill. The intertidal survey carried out by O'Sullivan identified very few quays and landing-places, possibly because boats there would have been drawn up onto the mudflats and marshes. These examples appear to be related to the use of this island as a pilotage for Limerick City in the 19th century. The fish trap, Quay Island 2, is a large U-shaped wooden fishtrap of unusual construction, with a narrow internal enclosed space and a rounded end. It is made up of two converging fences, each consisting of a double row of vertical wooden posts. There is a low mound of limestone slabs inside the flood fence, perhaps to prevent it from being undercut by erosion. This structure is thought to be a head weir, orientated so as to catch fish on the flooding tide and is thought to date from the mid-19th century.

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More traps are evident at Bunratty, on the north bank of the estuary (Fig. 12). These fishtraps are situated in the mudflat creek that slows south-eastwards across the mudflats, midway between Illaunbeg Point and Quay Island. The Medieval fishtrap discussed earlier was situated some 100m south-east of these examples. Bunratty 7 is a single post alignment of four roundwood posts, stretching 5m across the creek. Bunratty 8, c. 10m north of Bunratty 7, is also a single post alignment. It is 8m long, consisting of at least 17 roundwood posts, and crosses the creek and runs up along the northern bank. Bunratty 9, c. 60m north-west of Bunratty 8, is a double post alignment measuring c. 9m in length and comprised of at least eleven posts. Immediately downstream are three obliquely set posts, acting as braces for the main vertical structure. These three structures were probably small creek traps designed to

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catch fish in the water draining out of the mudflats at low tide. Similar creek traps were observed to the east, Bunratty 10 and 11, but there were not recorded in detail by O'Sullivan.

To the east of Quay Island is another island, called Green Island (Fig. 12). A single post alignment (Green Island 1) can be found to the south-west of the island, on the firm clays of the sloping foreshore. It runs diagonally down the foreshore from a low stone mound or ballast dump in a north-east/south-west direction. It is c. 17m long and consists of at least 36 regularly spaced, vertical roundwood posts. The structure is thought to be either the remains of a post-and-wattle flood fence of a small head weir or may be the poles of a small stake-net weir. It is probably post-medieval or modern in date.

Further east on the north bank of the estuary is Bush Island (Fig. 15). There are fishtraps located off both the western and eastern shores of the island. On the west and north-west shore a particularly large creek hooks around the island and enters the estuary between Bush island and Green Island, while on the east shore a wide, shallow creek appears from the north-east during the ebbing tide. At least eighteen fishtraps, of varying size and complexity, have been recorded around the island.

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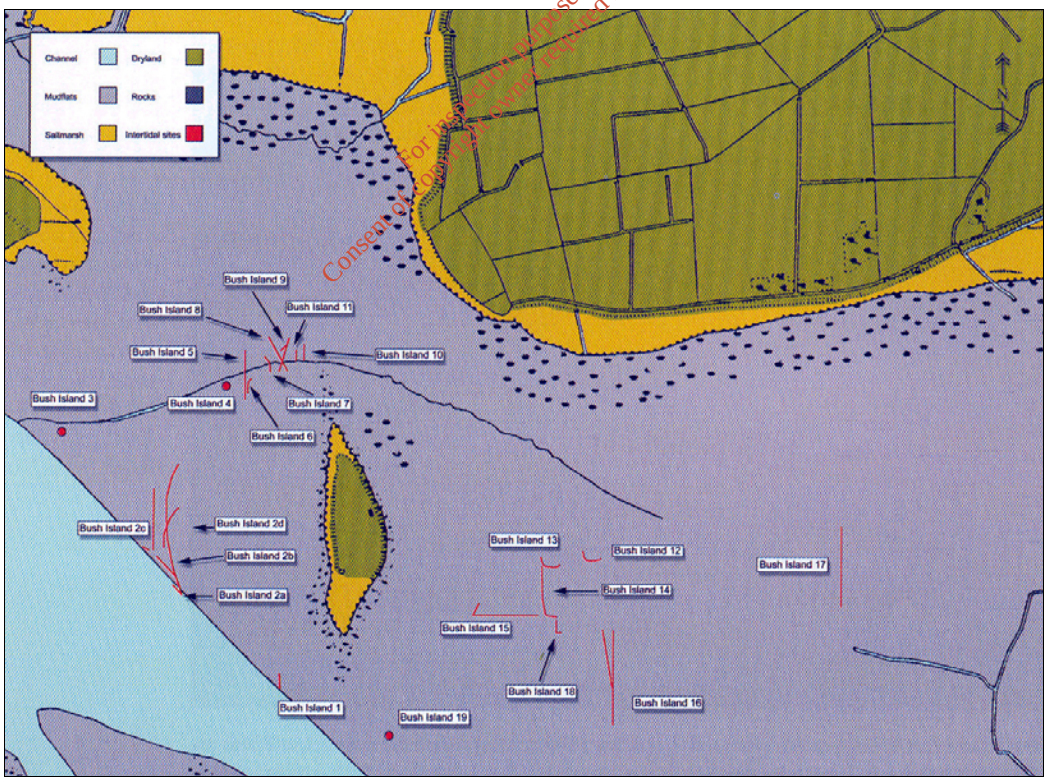


Figure 15: Location of Post-Medieval Fishtraps at Bush Island, Co. Clare (O'Sullivan, 2001).

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Bush Island 4-11 are a concentration of at least seven creek traps in a very confined area, indicative of the good fishing that must have been in the area. They are thought to represent several phases of activity. The structures are depicted on the OS 1st edition map but not on subsequent ones, thereby suggesting their use during the mid-19th century, although Bush Island 4 may be of medieval date. The structures Bush Island 12 to 18 represent several different types of fishtrap, such as C-shaped, L-shaped and straight post alignments. Bush Island 14 was depicted on the 1st edition OS map of 1841 but not subsequent editions. These head and stake weirs are probably 18th to 19th century in date and may have been owned and maintained by the landlords, labourers and tenants of Ballymorris House, which is located on the mainland to the north.

There are also a number of post-medieval fishtraps on the south side of the estuary. Just opposite of Bush Island is Carrigdirty Rock, where Neolithic and Bronze Age sites have already been discussed. Two post-medieval fishtraps and two possible post-medieval trackways have also been discovered (Fig. 6). Carrigdirty Rock 12 consists of a post-and-wattle panel measuring 2.2m long and 1m wide, c. 80m south-west of Carrigdirty Rock, on the mudflats just north of the creek. It has been interpreted as a trackway providing access to the mudflats south of the rock. Another post-and-wattle panel can be found at Carrigdirty Rock 13, beside a saltmarsh cliff, to the south of the mudflat creek. It measured 2.5m in length and 60cm wide, with other roundwood poles in the surrounding area. It has been interpreted as a trackway or platform providing access for fishermen accessing the saltmarhes to get to the nearby fishtraps.

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Carrigdirty Rock 14 is located on the upper foreshore near Carrigclogher Rocks, c. 160m south-west of Carrigdirty Rock. It consists of a substantial post-and-wattle fence and is c. 60m long. It is thought to represent the remains of a stake weir, designed to catch fish moving upstream or downstream between the island and the marshes. Carrigdirty Rock 15 is located on the main Shannon estuary channel at the low water mark, c.160m west of Carrigdirty Rock. It consists of a vertical post-and-wattle fence running 16m diagonally down the foreshore to below LWM. It appears to be the shore fence of a tidal head weir, orientated to catch fish on the flooding tide. It is of unknown date its small size and poor sate of preservation suggests a late medieval or post-medieval date.

Further west, on the shore opposite to Bunratty, and south east of Sod Island, is Maiden Rock (Fig. 11). The post-medieval fishtraps and post-and-wattle (LI004-031) at Maiden Rock are located adjacent to the townland of Mellon, Co. Limerick. They are situated on the west bank of the River Maigue, directly north of Rinekirk Point. There are at least five wooden structures, of which Maiden Rock 1 and 2 are substantial post alignments running down towards the River Maigue channel, Maiden Rock 3 is a post-and-wattle panel at the LWM and Maiden Rock 4 and 5 are two small post alignments at the rock itself.

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Maiden Rock 1 is on the foreshore immediately north of Rinekirk Point, running from the saltmarsh towrds the main river channel. It consists of a single post alignment running some 80m on a north-east/south-west orientation. It is constructed from c. 40 roundwood posts driven vertically into the clay. This structure is thought to be a 19th century stake-net weir, where a net was hung from the fence and weighted down with small stones against the force of the tide. Maiden Rock 2 is located also located on the estuarine clays, around 60m north-west of site 1. It too is a single post alignment, set on the same orientation, but appears to be shorter, at c. 30m long. This is also likely to be a stake-net weir but possibly earlier in date than site 1 and designed to catch fish coming down the River Maigue with the ebbing tide.

Maiden Rock 3 is on the estuarine clays just above the LWM on the channel of the River Maigue, just north-west of site 2. It consists of a horizontal post-and-wattle panel, exposed over an area measuring 5m by 2m. This panel is made from strong posts, around which some roundwood rods were woven. O'Sullivan has suggested that the panel may have been part of a trackway providing easier access to the end of the fishtrap or it may simply be a panel that drifted away from it original vertical structure. This structure is also thought to be post-medieval in date. O'Sullivan has also suggested that the fisheries around Maiden Rock were owned by the occupants of Mellon House in the adjacent townland. Maiden Rock 4 and 5 were two post alignments to the west of sites 1, 2 and 3, measuring 10-15m in length. They are situated to the south of the rocks, orientated north-west/south-east, and appear to be small creek traps of modern date.

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Other post-medieval features in the landscape include the church and graveyard at Mellon (LI004-00801, LI004-00802). These are the ruins of a Protestant church built in 1738, on the site of an earlier Catholic Church. This earlier church was known as Ardcanny Church, which was also once the parish name of the area. This was derived from the Irish 'Árd Caithne', meaning 'height of the arbutus tree'. To the east of the church site is a holy well (LI004-003). While often holy wells have no artificial features associated with them or if they do, they are frequently of modern construction, these places are often of ancient tradition. Some wells are found associated with ecclesiastical sites, while others may have their origins in pre-Christian well veneration and ritual activity. On the other hand some wells are of quite recent origin but it is often difficult to determine which is the case.

Early Modern

Large head weirs continued to be constructed and used at various locations along the estuary in the 19th century before they were prohibited in the middle of that century due to their danger to navigation and fish stocks.

In the early 19th century nearby Bunratty contained 1200 inhabitants. Up until a few years before Lewis's, in the early 1800's, the castle there was the residence of T. de Clare Studdert,

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who also erected a 'mansion' in the demense. The old castle was then being used as a police barracks. It was described by Lewis as 'a lofty and massive quadrangular structure, with a tower at each angle'. Studdert had also built a fine one-arched bridge over the Owenagarney River, along with a commodious quay, which was about to be enlarged, although boats of a large nature could already come alongside. Lewis notes that considerable amounts of 'sea manure' were landed here for use in the local area, along with turf, which was commonly brought from Kilrush. At the mouth of the Owenagarney River is Quay Island. The anchorage off this island, which was known as Bunratty Roads, was considered to be the best in the Shannon. It was here that the West India vessel discharged their cargoes for Limerick. Saints Island was considered to contain the richest land, and was inhabited by two families.

3.1.2 Maritime Archaeology and History

In an environment such as the Shannon estuary, boats would always have been one of the primary means of communication and transport. Prehistoric and early medieval people who inhabited the land around the estuary must have made extensive use of dug-out boats and other vessels, examples of which were found in the Fergus estuary. Plank-built boats and vessels constructed with reeds may also have been in use. Skin covered vessels, such as currachs and corracles were also commonly used in Irish waters. The arrival of the Vikings at the end of the 8th century would have introduced new boat building practices to the Irish. The Shannon estuary would have been attractive to the Vikings, given its strategic and economic importance. It is known that a Viking fleet and stronghold were established on these waters by the early part of the 9th century, and became a raiding base for much of the inland waterways of the country. Native Irish fleets were also active on the Shannon at that time.

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The arrival of the Anglo-Normans in 1169 led to much economic and social changes in the country. Many urban centres became successful ports and the protection of these ports and the safe passage of shipping was essential. Galleys, which were wooden, clinker-built, double-ended ships powered by oars, were employed to provide this protection. Bunratty, which seems to have acted as an outport for Limerick, was home to a number of galleys. The increase in mercantile activity led to a need for vessels with larger cargo-carrying capacity. This saw the emergence of the cog, which must have been commonly seen in the Shannon estuary. These vessels were clinker built and had flat, flush-laid bottoms.

Further developments in ship construction in the early 15th century. Carvel construction, with planking laid end to end, became more common, but the clinker method was seen found on smaller, more localised vessels. This saw a variety of new vessel types coming to Irish shore. The advantages of the Shannon estuary to these sea going vessels was that vessels of 200 tons could dock over 60 miles from the sea, a fact that allowed Bunratty to be involved in overseas trade.

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The 18th and 19th centuries saw an intensification of maritime activity around the Shannon estuary. There was a general increase in shipping and a boom in coastal industries, which required waterfront facilities and vessels to transport their goods. By the mid-18th century ships from Limerick port were involved in large-scale exportation of its hinterland's agricultural surplus to Europe and further afield.

With this amount of shipping activity over the years, there must also have been a considerable number of vessels lost in the estuary. Recording of shipwrecks was only initiated in the 1740's by Lloyd's, an insurance and shipping company in London. It was not until the middle of the 19th century that the systematic recording of shipwrecks was carried out by the British Board of Trade. These sources were usually only concerned with larger vessels so the loss of smaller, more localised vessel would have gone unrecorded, unless it features in local newspapers. Therefore the following list of shipwrecks is not a complete listing of vessels lost in the estuary around Sod Island and is biased towards vessels of a post-1740 date.

There are no records of any vessel being lost on or near Sod Island, but the closest loss appears to be *Treenaglass*, a 1513-ton steamer, ran aground and broke amidship at Bridges Bank, near Palaskenry (possibly Pallaskenry), Shannon estuary on 1 August 1833. There are a considerable number of vessels that have very general information on their place of loss. These have been included below, as there is a possibility that there were lost in the vicinity of Sod Island:

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- *Alice*, foundered in a gale in the Shannon on 30 March 1814;
- *Catherine*, was lost in the Shannon on the 4 November 1849;
- *Cicero*, was wrecked on the River Shannon in 1833;
- *Defiance*, lost in the Shannon in 1835;
- *Elizabeth and Mary*, went ashore in the Shannon on the 13 January 1843 but was got off;
- *Flora*, went ashore near Limerick in September 1802;
- *Georgina*, a schooner, collided with the SS Vale of Calder on the Shannon on the 9 May 1884 and sank immediately;
- *Hannah*, was lost near Limerick on the 22 January 1747;
- *Lark*, was lost in the Shannon on 28 January 1803;
- *Mary*, parted from her anchors and went ashore in the Shannon on the 24 December 1811;
- *Myrtle*, a 100ton vessel, was wrecked in the Shannon in 1828;
- *Peggy*, was lost in Limerick River in December 1790;
- *Solidade*, went ashore and was seriously damaged in Limerick River on the 28 December 1781;
- An unnamed French longboat capsized while transferring men to another ship in the River Shannon on the 4 November 1691; and
- An unnamed smack was lost in the Shannon in November 1850.

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3.1.3 Conclusion

The Shannon estuary has long been occupied and exploited by humans. Prehistoric foragers and farmers, medieval and postmedieval fishermen, mariners, farmers, landlords and labourers have worked on the land, foreshore and the waters themselves. While some of the archaeological remains from these people have been known about for a long time, others such as the numerous fishtraps were only discovered in recent years. As parts of the estuarine muds continue to be eroded more archaeological features may be revealed; likewise with the shipwreck record. There must be many more vessels lying in the estuarine muds, the place and time of loss forgotten. The potential for uncovering archaeological material in the vicinity of Sod Island is high, given the proven level of activity in the estuary in the past and the quality and frequency of archaeological remains already recorded.

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3.1.6 Sites and Monuments Record

The Sites and Monuments Record for the area adjacent to the proposed development site at Sod Island, Shannon Estuary, is detailed in Table 3.

Site No.	Sh/Pl/Tr	NGR	Townland	Class
LI003014	003/12/4	14088/15734	Shannongrove	Windwill
LI003015	003/12/4	14100/15722	Shannongrove	Potential site
LI003016	003/12/4	14106/15699	Shannongrove	Enclosure
LI003018	003/16/1	14128/15665	Shannongrove	Enclosure
LI003019	003/16/1	14131/15653	Shannongrove	Enclosure
LI003024	003/12/6	14250/15701	Ballydoole	Enclosure
LI003028	003/12/5	14157/15697	Shannongrove	House
LI004002	004/13/1	14338/15674	Cartown	Enclosure
LI004003	004/09/4	14366/15679	Cartown	Holy well
LI004005	004/09/2	14415/15764	Mellon	Enclosure
LI004006	004/13/2	14434/15651	Mellon	Enclosure
LI00400801	004/13/2	14451/15672	Mellon	Church
LI00400802	004/13/2	14451/15672	Mellon	Graveyard
LI004023	004/09/6	14491/15696	Mellon	Castle (possible site)
LI004031	004/09/3	14497/15801	River Maigue	Fish trap(s)
CL061007	061/08/1	142559/15989	Saints Island	Enclosure
CL061008	061/04/1	14274/16160	Clonmoney West	Motte and bailey
CL061009	061/04/1	14314/16143	Clonmoney West	Ringfort
CL061010	061/04/2	14344/16185	Clonmoney West	Possible enclosure
CL061012	061/04/2	14397/16174	Clonmoney North	Potential site
CL06101301	061/08/3	14484/15958	River Shannon Bunratty West	Fish weir
CL06101302	061/08/3	14483/15951	River Shannon Bunratty West	Fish weir
CL06101303	061/08/6	14485/15938	River Shannon Bunratty West	Fish weir
CL062001	062/01/4	14498/16092	Bunratty East & Bunratty West	Historic town
CL06203101	062/05/1	14507/16022	River Shannon Bunratty West	Fish weir
CL06203102	062/05/1	14503/16013	River Shannon Bunratty West	Fish weir
CL06203103	062/05/1	14503/16007	River Shannon Bunratty West	Fish weir

Table 3: Sites and Monuments Record for the area adjacent to the proposed development site at Sod Island.

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3.2 Site Surveys

3.2.1 Geology and seabed sediments

The substrate at the proposed development is characterised by low backscatter returns without texture, indicative of fine muddy seabed (Fig. 16). Little of no bedform development at the site provides further indication of this fine silty mud. Figs. 16 displays the mosaic sonograph of the survey area.

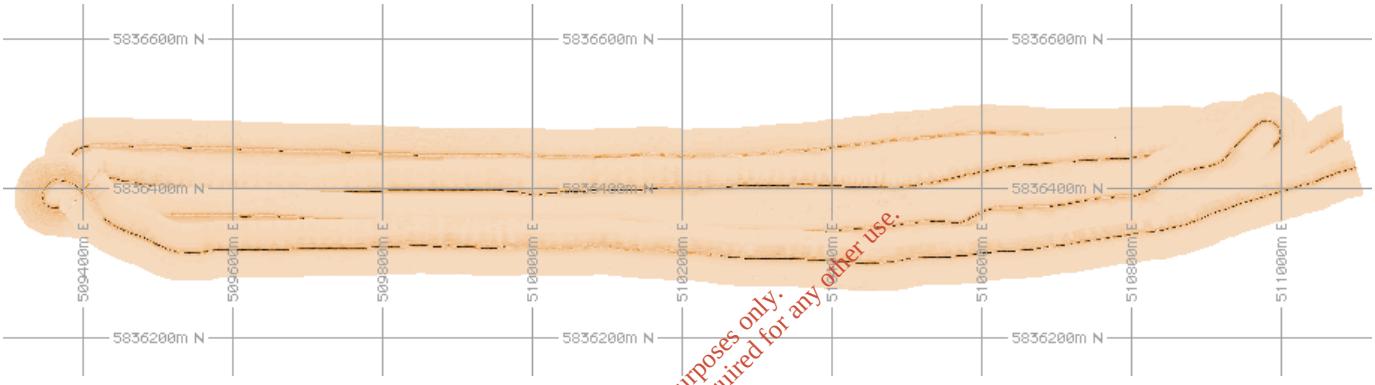


Figure 16: Mosaic sonograph showing the low to medium-high backscatter returns at the location of the proposed dump site. (Co-Ordinates UTM)

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3.2.2 Bathymetric Data

The bathymetric data of the site are displayed as a 2-dimensional and 3-dimensional contour plots in Fig. 17. Bathymetry ranges from <1m on the north-western margin of the survey area, to a maximum depth of over 6m in an isolated depression of approximately 0.4km x 0.2km to the north east. The survey zone's shallow area (<2m) extends for approximately 1km in the direction of the Estuary's South Channel. The majority of the survey identified bathymetry in the range of 2-2.7m. From Fig. 17, it is apparent that the proposed development extends across a range of depths from 2m-6m.

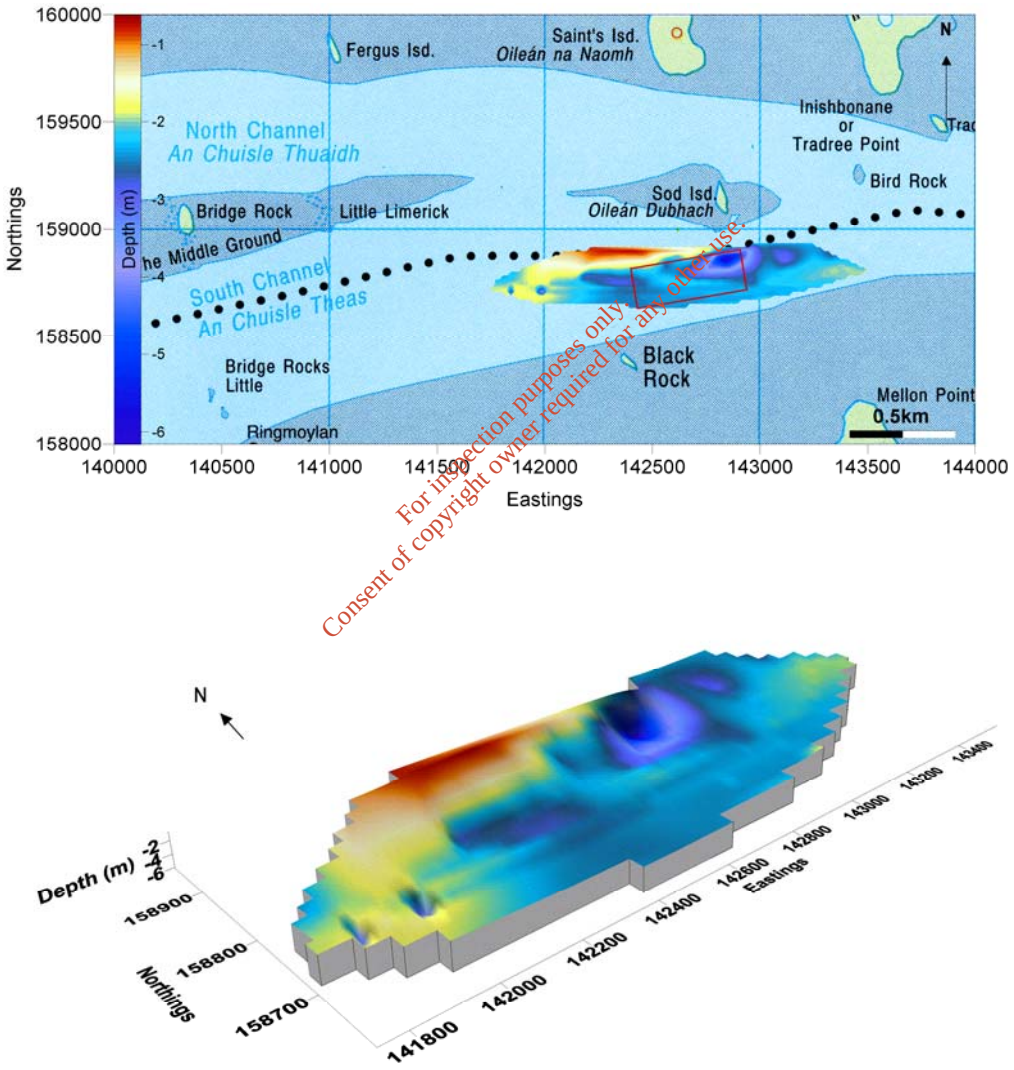
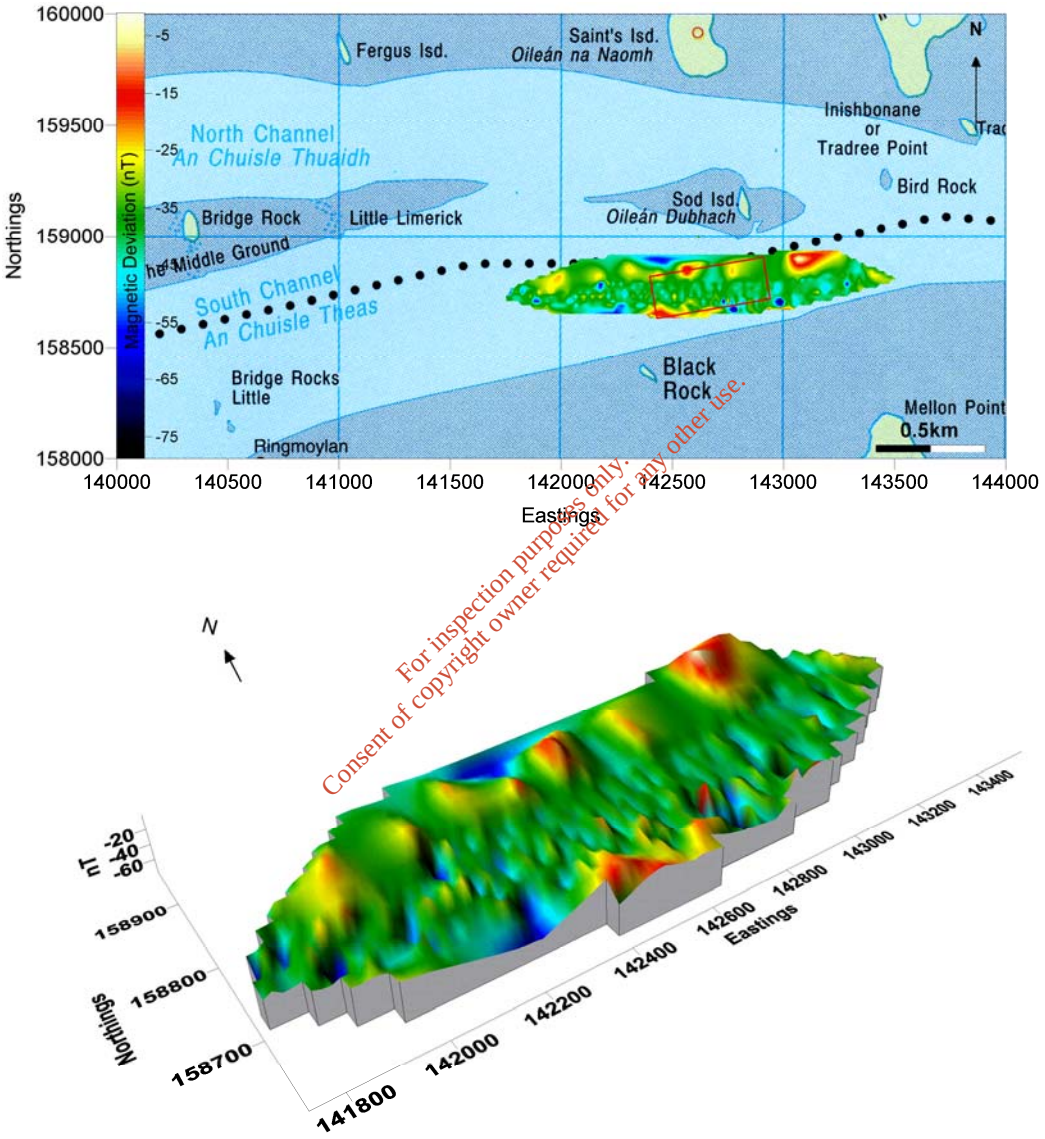


Figure 17: 2- and 3-dimensional contour plot of bathymetric data overlain on Discovery Series Map 65 (OSI, 1999, 2nd Edition).

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3.2.3 Magnetic Survey

The results obtained from the magnetometer survey range from +200nT to –1200nT on a background of 0nT. The results are presented in Fig. 18 as 2-dimensional and 3-dimensionsal contour plots of magnetic deviation.



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Figure 18: 2- and 3-dimensional contour plot of magnetic data overlain on Discovery Series Map 65 (OSI, 1999, 2nd Edition).

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The results are dominated by magnetic deviation in the range of -35 to -45nT, interspersed with areas of approximately –50nT. There are nine anomalous magnetic signatures (M1-M9) in the survey data. The identification tag and position of each is presented in Table 4. Fig. 19 displays the location of the anomalies overlain on a chart of the survey area. The west of the survey area, from 142400E, is interspersed with anomalies of approximately –60 to –65nT, while east of this point, the majority of anomalies are between –10 and –20nT. Both areas are, however, widely-interspersed with minor deviations. In terms of the data range, M8 is the most significant large anomaly, with a deviation of up to –5nT and an area of approximately 1km^2. Sites M2 and M8 are the only anomalies on the fringes of the development, while the majority is clustered around the proposed site.

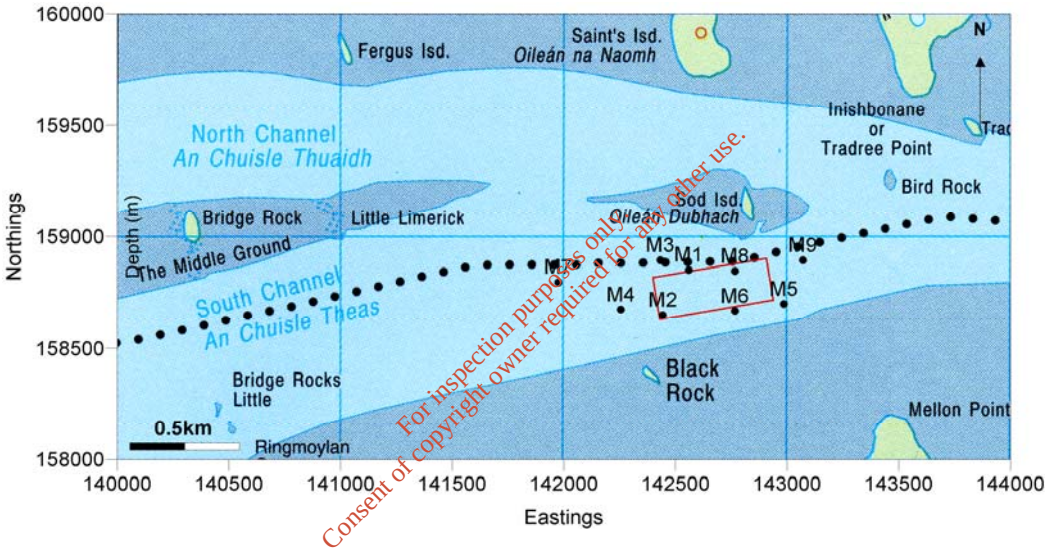


Figure 19: Anomaly positions and ID tags for the 9 magnetic anomalies identified at the site overlain on Discovery Series Map 65 (OSI, 1999, 2nd Edition).

ID/Tag	Easting	Northing
M1	142559.855106	158852.178273
M2	142444.221165	158651.340946
M3	142432.048714	158894.7806
M4	142255.555001	158675.684601
M5	142985.874133	158700.028877
M6	142766.778704	158669.598998
M7	141975.599179	158797.404739
M8	142766.778704	158846.09267
M9	143071.078187	158894.7806

Table 4: Co-ordinates and ID-tags for the anomalies interpreted from magnetic contour plot of the survey area. Their location is shown in Fig. 19.

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3.2.4 Side-scan sonar survey results

No anomalies were interpreted from the side-scan sonar survey south of Sod Island, Shannon Estuary, Co. Limerick.

3.2.5 Data integration and interpretation

The spatial relationship between bathymetry, magnetic anomalies M1-M9 and the development site is displayed in Fig. 20. The shallow bathymetric data reflects the submarine morphology of Sod Island. The proposed development is directly associated with magnetic anomalies M2 and M8 and with a range of water depths greater than 2m, including the deepest area of the channel. With strong indications of extensive anthropogenic activity in the area, and the field of minor deviations exposed in the magnetic data in Fig. 18, it is likely that the magnetic results reflect cultural debris at the site. These have not been displayed on the 500kN side-scan sonar record at the site, likely due to accretion of fine muddy riverbed material.

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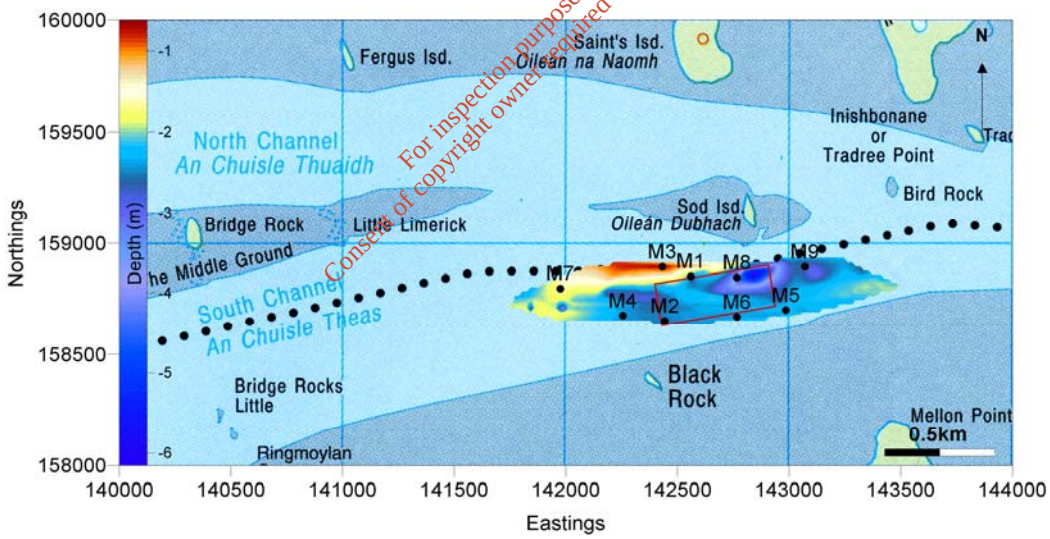


Figure 20: Bathymetry, magnetic anomalies M1-M9 and the development site overlain on Discovery Series Map 65 (OSI, 1999, 2nd Edition) of the Shannon Estuary.

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4 CONCLUSIONS

- No sites of archaeological potential are interpreted from 500 kHz side-scan sonar data acquired in the survey of the proposed cable site.

- Nine magnetic anomalies are identified from the site, however only anomalies M2 and M8 are in direct association with the proposed development. With strong indications of extensive anthropogenic activity in the area, and the field of minor deviations, it is likely that the magnetic results reflect cultural debris, which has been buried by sediment accretion processes at the site.

- The proposed development is unlikely to have an adverse effect on any potential buried cultural material, as it will lie on the seabed and involves no invasive activity on the riverbed.

5 RECOMMENDATIONS

- The proposed dump site for dredged material should proceed south of Sod island, Shannon Estuary, Co. Limerick.

- Procedures for archaeological monitoring during engineering works are not required as the development involves no dredging or invasive activity on the riverbed.

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SECTION 6

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Wessex Archaeology

Foynes Harbour and Approaches
Proposed Dredging and Disposal

Archaeological Diving Inspection

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FOYNES HARBOUR AND APPROACHES
PROPOSED DREDGING AND DISPOSAL

ARCHAEOLOGICAL DIVING INSPECTION

Wessex Archaeology
September 1999
ref: 47062

in association with

North East Diving Services Ltd.

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on behalf of

Foynes Port Company

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FOYNES HARBOUR AND APPROACHES
PROPOSED DREDGING AND DISPOSAL

ARCHAEOLOGICAL DIVING INSPECTION

SUMMARY

Wessex Archaeology carried out an archaeological diving inspection in the vicinity of Foynes Port, Limerick (NGR 1250 1520) from 7 to 11 September 1999 in association with North East Diving Services Ltd. (NEDS Ltd.) on behalf of Foynes Port Company (FPC). The inspection was required in connection with an application for a consent to dump at sea from the Department of Marine (advised by Dúchas) and was intended to facilitate decisions regarding any further investigation or mitigation that might be required prior to, or in the course of, the proposed works.

The inspection was intended to 'diver truth' or otherwise identify seven anomalies selected by Dúchas from sidescan surveys carried out on behalf of FPC within the area potentially affected by the proposed development.

Features which may reasonably be associated with each of the recorded anomalies were observed at the location of each anomaly. None of the observed features was of archaeological interest.

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FOYNES HARBOUR AND APPROACHES
PROPOSED DREDGING AND DISPOSAL

ARCHAEOLOGICAL DIVING INSPECTION

ACKNOWLEDGEMENTS

This investigation was commissioned by North East Diving Services Ltd. (NEDS Ltd.) on behalf of Foynes Port Company. Michael Punch and Partners are consulting engineers, and geophysical investigation was carried out by Hydrographic Surveys Ltd. Wessex Archaeology would like to thank David Chapman of NEDS Ltd, the chief executives and harbourmasters of Foynes Port Company, Joe Murphy of Michael Punch and Partners and Barry Conroy of Hydrographic Surveys Ltd.

Archaeological monitoring was undertaken by Dúchas, The Heritage Service. Wessex Archaeology would like to thank Karl Brady and Connie Kelleher of Dúchas for their assistance and advice.

Fieldwork was carried out by Kit Watson and Antony Firth supported by NEDS Ltd. Wessex Archaeology would like to thank Robert Clarke, Ciaran Monks and Eamon Howlin of NEDSLtd, Colin Johnston of Hydrographic Surveys, and Pat, Willie, Paul and Brian of FPC pilot boats for their hard work and good humour.

This report was compiled by Kit Watson and Antony Firth. The illustrations were prepared by Karen Nichols. The project was managed for Wessex Archaeology by Antony Firth.

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FOYNES HARBOUR AND APPROACHES
PROPOSED DREDGING AND DISPOSAL

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FOYNES HARBOUR AND APPROACHES
PROPOSED DREDGING AND DISPOSAL

ARCHAEOLOGICAL DIVING INSPECTION

REF: 47062

1. INTRODUCTION

1.1. This document has been prepared by Wessex Archaeology for North East Diving Services Ltd. (NEDS Ltd.) in connection with proposed capital dredging and disposal in the vicinity of Foynes Port (NGR 1250 1520) (Fig. 1) by Foynes Port Company (FPC).

1.2. The proposed works comprise dredging in the approaches to and within Foynes Inner Harbour, where silt, clay and rock will be removed generally to depths of –8.1 m and –12.0 m. Arisings from the dredging will be disposed of at two proposed dump sites, North Dump and South Dump, within the main channel of the Shannon estuary. The Inner Harbour at Foynes has been subject to maintenance and capital dredging in the past, with arisings previously disposed of in the vicinity of the North Dump.

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1.3. The capital works are subject to consent to dump at sea from the Department of Marine, which is advised on archaeological matters by Dúchas, the heritage service. Consent is subject to satisfactory provision for identifying archaeological material within the area of the works and for mitigating the effects of the works on such material.

1.4. At the request of Dúchas, FPC commissioned Hydrographic Surveys Ltd. to carry out a geophysical investigation comprising magnetometer and sidescan surveys (Hydrographic Surveys Ltd. July 1999). Following discussion between the Hydrographic Surveys Ltd. and Dúchas, anomalies that warranted archaeological inspection were identified at seven locations. Two locations were reported to be at c. 40.5 m depth, one location at c. 14.5 m depth, and four locations at up to 11.5 m depth. The recorded position of each anomaly is as follows:

Anomaly	NGR	
	E	N
Inner Harbour		
H	125613	152177
J	125394	152102
K	125048	151878
L	125231	152142
South Dump		
E	122495	151778
North Dump		
A	122608	152765
F	122494	152821

1.5. Dúchas required that 'diver truthing' be carried out at the seven locations in order to establish the archaeological potential of each anomaly. Wessex Archaeology, in

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association with NEDS Ltd., was commissioned to carry out an archaeological diving inspection comprising diving operations at each location.

1.6. The archaeological diving inspection was carried out within the legal framework of the National Monuments Act 1930-1994 (see Department of Arts, Heritage, Gaeltacht and the Islands 1999). Licences to dive/survey and a to use a detection device were sought and obtained from Dúchas (licence numbers 99D014 and 99R038 respectively). The licence applications were accompanied by a method statement (Wessex Archaeology ref: T5072, dated 26/08/99).

1.7. Wessex Archaeology carried out the archaeological diving inspection from 7 to 11 September 1999. This report sets out the background, methods, results and conclusions of the inspection.

2. ARCHAEOLOGICAL AND HISTORICAL BACKGROUND

2.1. Prior to the survey, secondary sources were made available to Wessex Archaeology, though no formal desk-based assessment was required.

2.2. The archaeological potential of the Shannon estuary extends back to prehistoric times, with evidence of late Bronze Age exploitation of coastal wetlands in the upper Shannon estuary (O'Sullivan 1995a).

2.3. Archaeological and documentary evidence supports popular stories of Viking activity within the Shannon estuary, established in fortified bases known as *longphorts* (Kelly and O'Donovan 1998).

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2.4. Medieval fishweirs are recorded c. 8 km to the east of Foynes in the Deel Estuary (O'Sullivan 1995b).

2.5. The strategic value of Foynes Island was recognised in 1597 when Sir John Norris recommended that the island should be fortified as part of the defences of the city of Limerick (Spellissy n.d.: 167).

2.6. The natural advantages of the sheltered water which now forms Foynes Port are likely to have been recognised from the earliest times. In 1837 The Commissioners for the Improvement of the River Shannon reported that:

> *the harbour of Foynes … This place affords excellent shelter from all winds, being protected from the south and west by high lands adjoining the river banks, and from the north and north-east by Foynes Island. The harbour, in fact, consists of the channel that separates Foynes Island and the mainland, in which these is an ample depth of water at all times of tide.*
>
> (quoted in Spellissy n.d.: 167)

2.7. The West Pier was built in 1847, and in 1858 the Waterford and Limerick Railway linked the waterfront to the rail network (Spellissy n.d.: 167). During the nineteeth century, Foynes was regularly used by ships in the timber trade with Russia and Scandinavia, and by ships engaged in transatlantic trade. The independence of

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Foynes harbour from Limerick Harbour Board was maintained through a harbour order in 1890 (Spellissy n.d.: 168).

2.8. In 1936 the Limerick Harbour Commissioners decided to establish an airport (now Shannon International), but Foynes was chosen as a temporary home for a transatlantic flying boat service, with scheduled services starting in June 1939. The service became dominated by the movement of military personnel during World War Two, and was phased out towards the end of 1945 (Spellissy n.d: 169). The flying boats moored and took off in the inner harbour, with provision for landing in the main channel.

2.9. No wrecks are known in the development area. However one ship is recorded as being blown from its mooring at Foynes (Spilling Rock), and a great many ships have been lost in the Shannon in the short time that records have existed (Bourke 1994, 1998).

3. AIMS AND OBJECTIVES

3.1. The aim of the diving inspections was to produce information to facilitate decisions regarding any further investigation or mitigation that might be required prior to or in the course of development.

3.2. The inspections were intended to 'diver truth' or otherwise identify anomalies selected by Dúchas from sidescan surveys carried out on behalf of FPC within the area potentially affected by the proposed development.

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4. METHODOLOGY

4.1. The diving inspections were to avoid damage to any archaeological features or deposits that appeared to be worthy of preservation *in situ* or controlled excavation.

4.2. FPC provided Wessex Archaeology with available magnetometer, sidescan and bathymetric data to enable the planning of the dives on the selected anomalies.

4.3. The position of each location was fixed by Hydrographic Surveys using Trimble differential GPS integrated with surveying software. A 5 x 5 m box was delimited at each location, centred on the recorded position of the relevant anomaly. A buoyed shotline was dropped as the vessel entered the box.

4.4. An archaeologist inspected each buoyed location.

4.5. The inspection at each location comprised a series of circular searches using a suitable tape measure at intervals of 5 m, 10 m and 15 m. This pattern of inspection was varied according to on-site conditions. Notably, health and safety considerations limited the circular searches at the North Dump site to 5 m only.

4.6. Diving operations were carried out using surface supplied diving equipment comprising a high pressure bank, integrated umbilical with hardwire communications

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and a KM 28 band mask. The diving team comprised diving archaeologist, archaeological supervisor/tender, diving supervisor, standby diver and boat crew. Seven dives were made, as follows:

Dive No.	Date	Diver	Bottom Time	Anomaly	Location
101	07/09/99	A. Firth	51	E	201
102	07/09/99	K Watson	58	K	202
103	07/09/99	A. Firth	19	L	203
104	08/09/99	K.Watson	78	J	207
105	08/09/99	A. Firth	37	H	206
106	11/09/99	K. Watson	15	F	205
107	11/09/99	A. Firth	14	A	204

4.7. The position of the buoyed shotline was checked using differential GPS after each inspection was completed.

4.8. The results of the survey were recorded by Wessex Archaeology using *pro forma* recording sheets and a continuous unique numbering system.

5. RESULTS

5.1. GENERAL OBSERVATIONS

5.1.1. Limitations were imposed by tidal currents at all seven locations. Diving could only take place within a one hour window at slack water. Additionally, the check of buoy positions after each inspection was impeded by the difficulty of holding relatively long shotlines taught against the tide.

5.1.2. At all seven locations visibility was extremely poor with no natural light below c. 3 m and through-water visibility of c. 50-300 mm with torchlight.

5.1.3. The North Dump and South Dump, sited in the main channel of the Shannon, were exposed to high winds from the south and south west.

5.1.4. Anomalies A and F were sited within the North Dump at depths of 34 m and 36 m at low tide respectively. Due to the need to avoid enforced decompression stops in rapidly changing weather and tidal conditions, diving on these anomalies was restricted to short bottom times on low water slacks.

5.2. INNER HARBOUR

Location 202 / Anomaly K

5.2.1. Sidescan records indicated a flat seabed with low irregular linear features (see Fig. 2 inset).

5.2.2. An archaeological inspection of 58 minutes at a maximum depth of 15 m was carried out. Three circular searches were undertaken at 5, 10 and 15 m (Fig. 2).

5.2.3. A silty clay sea bed was found to be broken by a series of smooth edged linear features, c. 1 m deep, running approximately west to east. Although eroded the linear

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features appear to be artificial in origin. Modern debris in the form of hawser and steel fragments were also noted.

5.2.4. The recorded anomaly appears to have been caused by shallow linear depressions, which appear to be scars from previous maintenance dredging using a trailing suction device.

Location 203 / Anomaly L

5.2.5. Sidescan records indicated a square feature with linear feature running to the east (see Fig. 3 inset), probably a mooring block (see also letter K. Brady to K. Thomas 09/08/99, ref. F94/5908/98).

5.2.6. An archaeological inspection of 19 minutes at a maximum depth of 8 m was carried out (Fig. 3).

5.2.7. A mooring block and ground line was located 4 m from the shot. The mooring block lay on a clay bottom covered in pebbles and gravel at the top of a slope towards the south. The mooring block was still in use for the vessel *Maracu-na*.

5.2.8. Given the likely identification of the anomaly the inspection was terminated.

5.2.9. The recorded anomaly appears to have been caused by a mooring block and chain from yacht moorings, which are still in use.

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Location 206 / Anomaly H

5.2.10. Sidescan records indicated an indistinct isolated feature on flat seabed (inset Fig. 4).

5.2.11. An archaeological inspection of 37 minutes at maximum depth of 12 m was carried out. Three circular searches were undertaken at 5, 10 and 15 m (Fig. 4).

5.2.12. A flat seabed of clay with some covering of small stones and shell was found to be featureless except for partly buried polythene sheet or polythene bags extending between 1.5 and 3.5 m west of the centre of the shot. The polythene was upstanding by up to c. 0.3 m and was associated with domestic refuse (a modern bottle).

5.2.13. The recorded anomaly appears to have been caused by the polythene.

Location 207 / Anomaly J

5.2.14. Sidescan records indicated a distinct isolated feature (inset Fig. 3).

5.2.15. An archaeological inspection of 78 minutes at a maximum depth of 8.5 m was carried out. Three circular searches were undertaken at 5, 10 and 15 m (Fig. 3).

5.2.16. A clay seabed covered with coarse sand and broken shell was found to be cut by a linear scar running east to west c. 10 m from the centre of the search. A harder surface clay layer c. 30 mm deep was undercut by the sides of the linear scar suggesting either recent origin or active erosion of the sides of the scar. The depth of the scar was not determined but exceeded 0.3 m.

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5.2.17. Other debris noted during the search included a small piece of timber partly embedded in the seabed but unassociated with any other structure or artefacts, a piece of modern steel debris 2 m long by 0.4 m high, and several stones lying on the seabed.

5.2.18. The recorded anomaly Anomaly probably caused by shallow linear depression – ?scar from previous maintenance dredging (trailing suction)

5.2.19. The recorded anomaly appears to have been caused by a shallow linear depression, which appears to be a scar from previous maintenance dredging using a trailing suction device, or by piece of modern steel debris.

5.3. SOUTH DUMP

Location 201 / Anomaly E

5.3.1. Sidescan records indicated an upstanding feature (rock?) with large shadow on uneven seabed scattered with other smaller upstanding features (see Fig. 5 inset).

5.3.2. An archaeological inspection of of 51 minutes at a maximum depth of 11 m was carried out. Three circular searches were carried out at 10 m, 15 m then 5 m (Fig. 5).

5.3.3. A series of large stones/small rocks were scattered across the seabed, which was otherwise vcovered by silt and small cobbles. The largest rock was c. 2 m long, upstanding by c. 0.5 m and located 0.5 m from the shot. No other material was observed.

5.3.4. The recorded anomaly appears to have been caused by a large upstanding rock.

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5.4. NORTH DUMP

Location 204 / Anomaly A

5.4.1. Sidescan records indicated an isolated feature (see Fig. 6 inset).

5.4.2. An archaeological inspection of 14 minutes to a maximum depth of 34 m was carried out. A circular search at 5 m was carried out (Fig. 6). The seabed comprised sand with silt and occasional rocks. No other material was observed.

5.4.3. The recorded anomaly appears to have been caused by one or more upstanding rocks.

Location 205 / Anomaly F

5.4.4. Sidescan records indicated a feature with a sharp shadow with other possible features in the vicinity (see Fig. 6 inset).

5.4.5. An archaeological inspection of 15 minutes to a maximum depth of 36m was carried out. A circular search at 5 m was carried out (Fig. 6). The seabed was composed of coarse sand with a large c. 1 m high sand dune/ridge to the east of the shot line.

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5.4.6. The recorded anomaly appears to have been caused by a large sand wave c. 1.0 m high.

6. CONCLUSION AND RECOMMENDATIONS

6.1. Wessex Archaeology, in association with North East Diving Services Ltd, carried out a series of 7 archaeological inspection dives. The investigation was intended to facilitate decisions regarding any further investigation or mitigation that might be required prior to or in the course of development by identifying anomalies selected from a sidescan survey.

6.2. Features which may reasonably be associated with each of the recorded anomalies were observed at the location of each anomaly. None of the observed features was of archaeological interest:

Inner Harbour

202	K	Anomaly probably caused by shallow linear depressions – ?scars from previous maintenance dredging (trailing suction).
203	L	Anomaly probably caused by mooring block and chain from yacht moorings, which are still in use.
206	H	Anomaly probably caused by area of polythene/polythene bags up to 3.3 m long embedded in seabed and upstanding by up to 0.3 m.
207	J	Anomaly probably caused by shallow linear depression – ?scar from previous maintenance dredging (trailing suction) or by a piece of modern steel debris.

South Dump

201	E	Anomaly probably caused by a large upstanding rock c. 0.5 m high x 2.0 m long.

North Dump

204	A	Anomaly probably caused by one or more upstanding rocks.
205	F	Anomaly probably caused by large sand wave c. 1.0 m high.

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6.3. The methodology adopted was such that the presence of any sizeable structure such as a wreck protruding from the seabed within 15 m (5m for anomalies A, F and L) of the location of each anomaly would have been snagged or otherwise encountered. Any concentration of surface artefacts falling within the area of each circular search is also likely to have been observed.

6.4. However, the presence of artefacts, structures or deposits that are entirely buried beneath the seabed cannot be discounted. The line spacing of the magnetometer survey was too coarse to conclude confidently that buried metal artefacts or structures would have been recorded by the geophysical investigations.

6.5. It should be noted that although all the sidescan anomalies inspected archaeologically proved not to be of archaeological interest, it is conceivable that some of the sidescan anomalies that FPC was not required to further investigate because of their apparent geological or modern origin could prove to be caused by archaeological features. However, the potential for other sidescan anomalies proving to be of archaeological interest should be tempered by acknowledgment of the degree of construction and

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maintenance (including dredging) that has occurred within the Inner Harbour since the nineteenth century.

6.6. Given the scope for the presence of buried or otherwise unrecognised archaeological features, it may be appropriate to make provision for archaeological observations during construction in the form of an intermittent watching brief and/or a call-out facility in the event of artefacts or structures being uncovered. In any case, all staff engaged in construction should be reminded of their legal obligations in respect of reporting archaeological objects under the National Monuments Acts 1930-94.

6.7. The effectiveness of archaeological observations during construction will depend to a large degree on the construction methodology. It may be appropriate to seek further archaeological advice, to the satisfaction of Dúchas, once the construction methodology has been confirmed.

7. ARCHIVE

7.1. The project archive comprising paper, graphic and photographic records has been compiled under the project reference number 47062 and is currently held at the offices of Wessex Archaeology. The archive will be deposited on instruction from the client in a suitable repository nominated by Dúchas.

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8. REFERENCES

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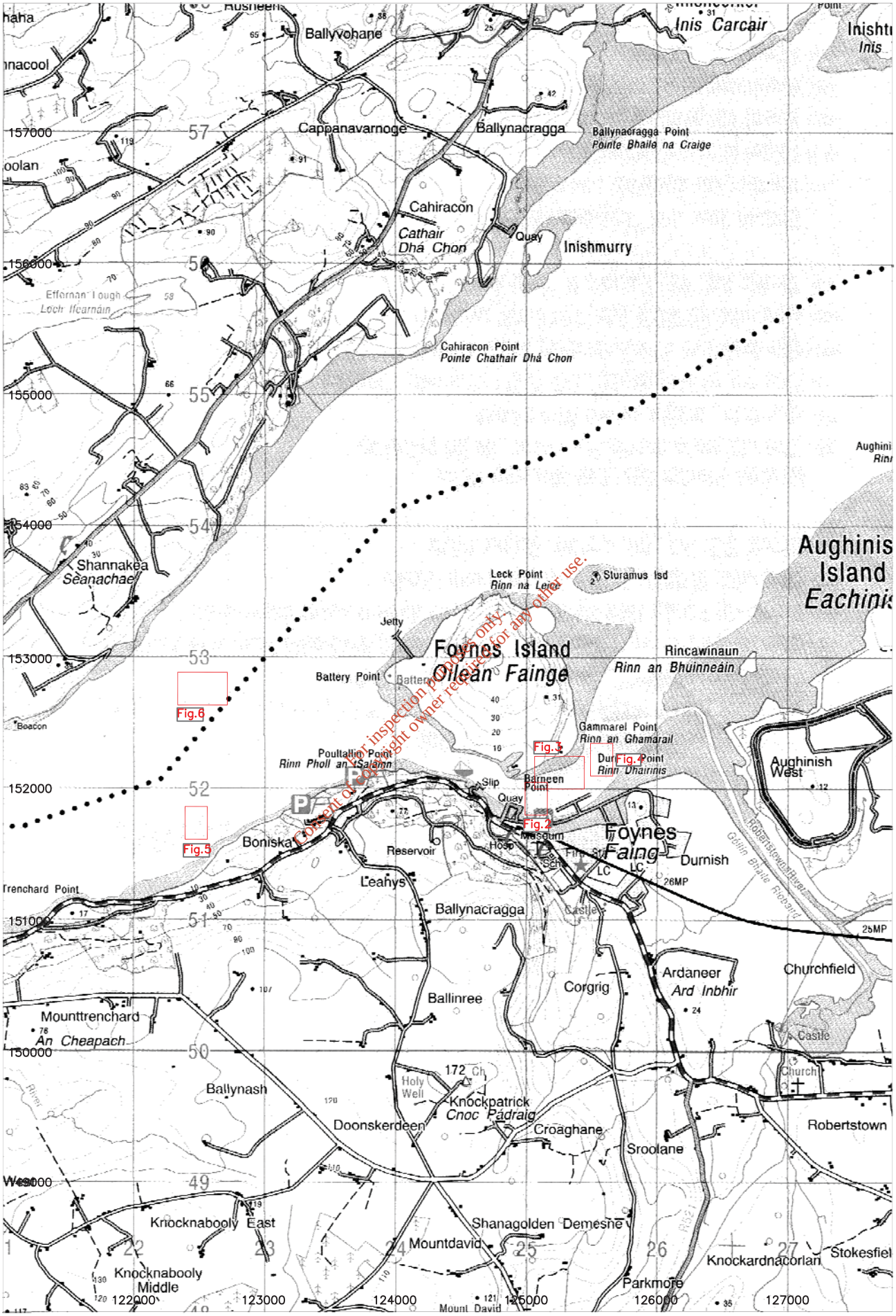


Figure 1

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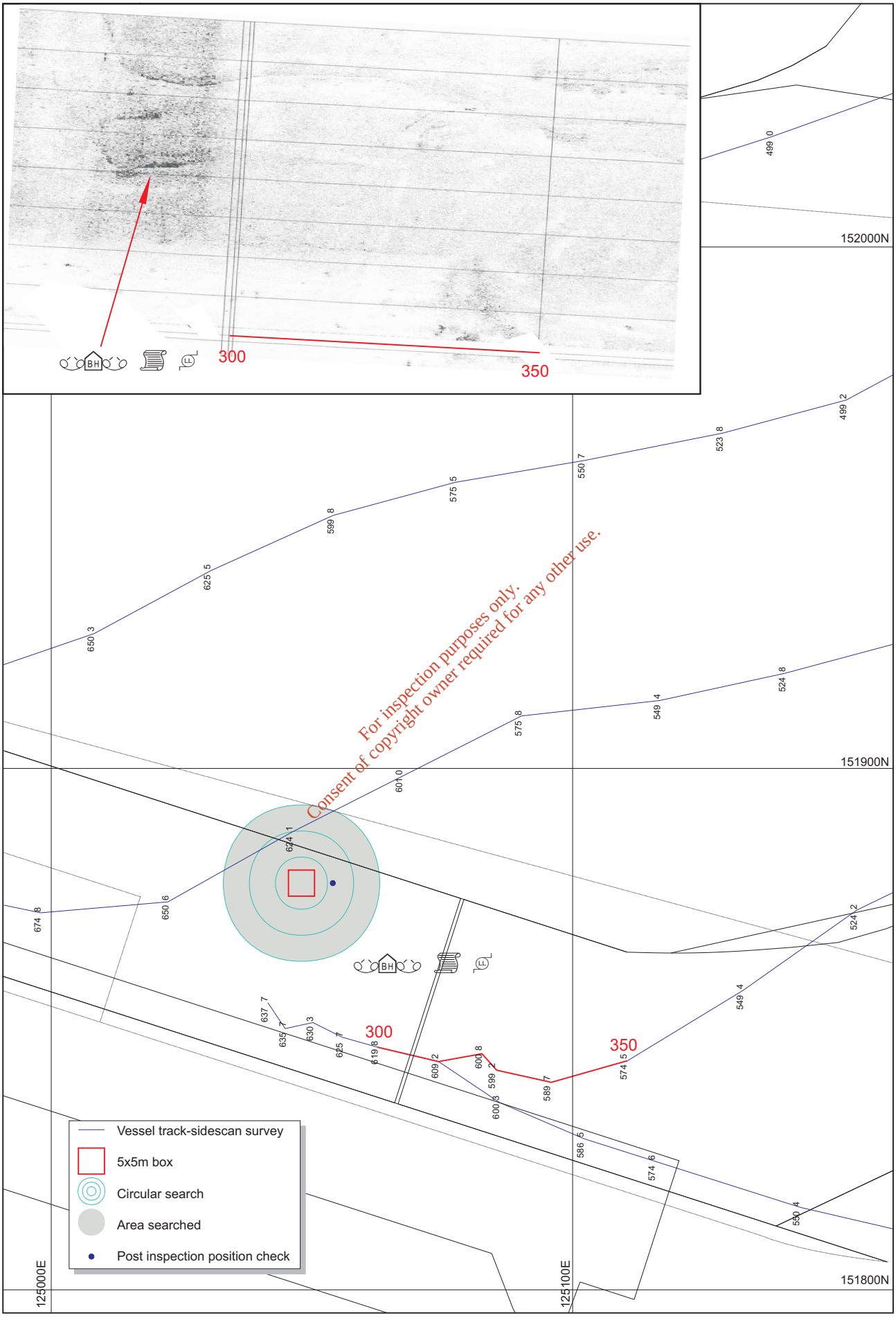


Figure 2

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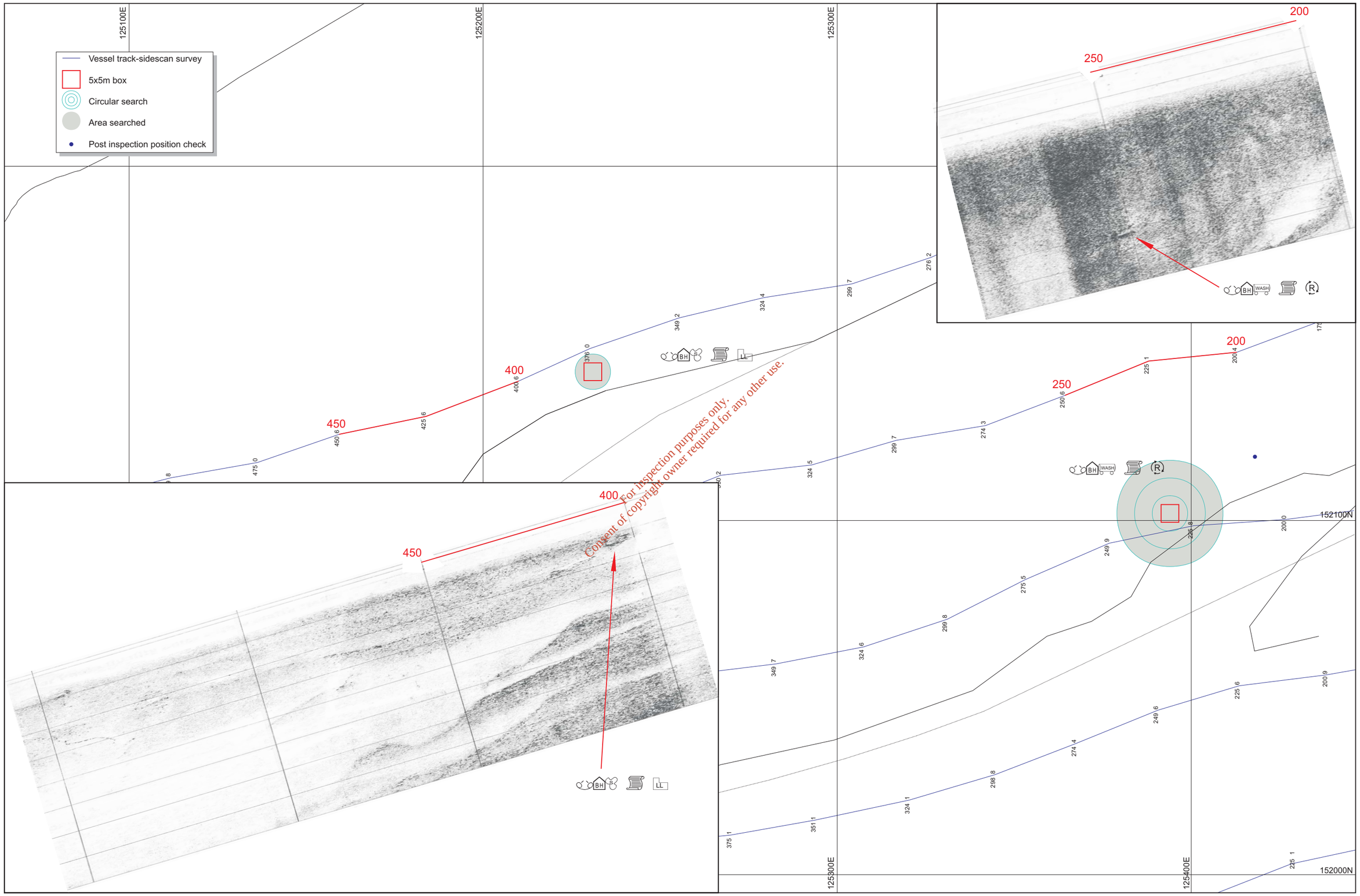
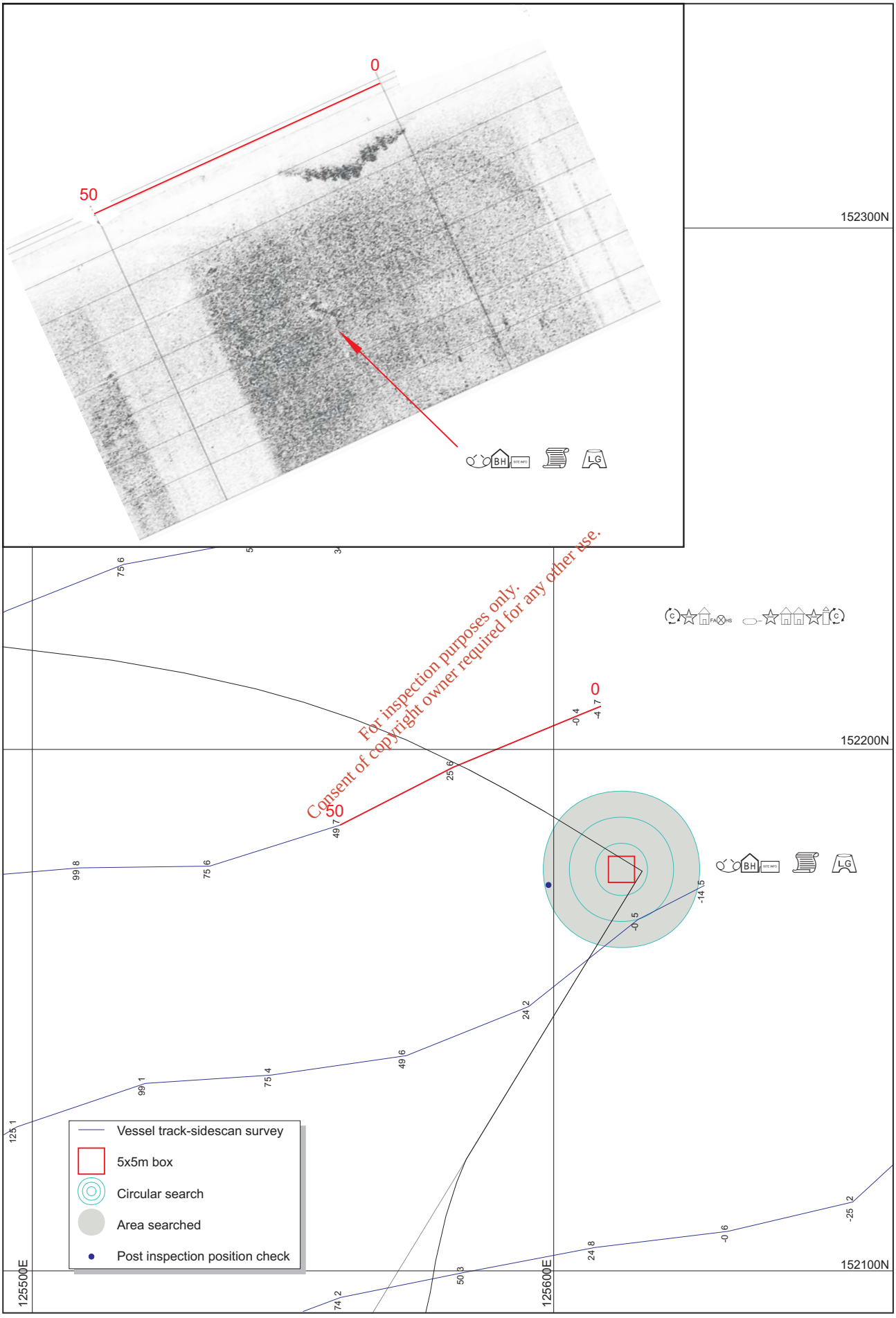


Figure 3

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Figure 4

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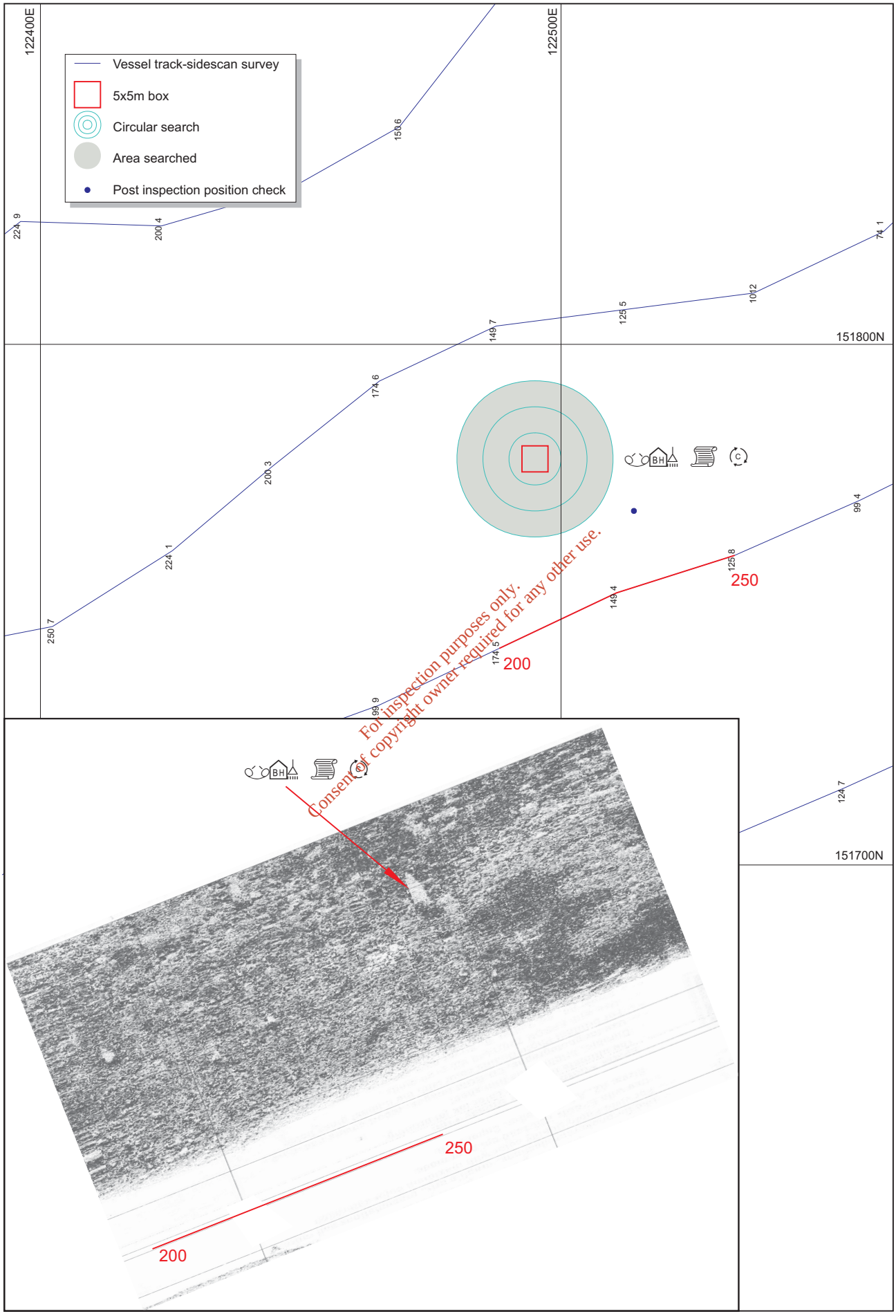
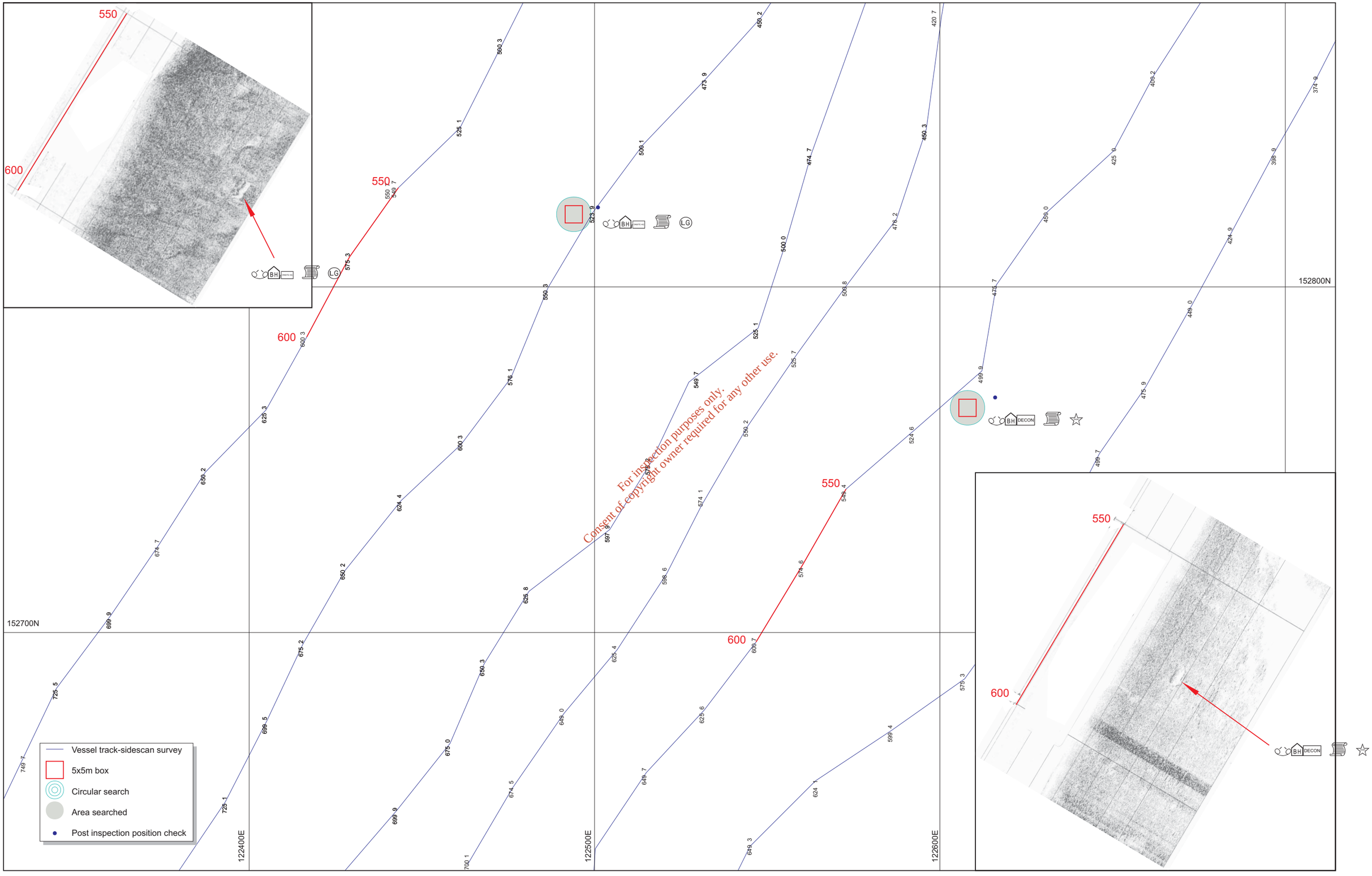


Figure 5

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Figure 6

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Wessex Archaeology

Foynes Harbour and Approaches Capital Dredging and Disposal

Archaeological Monitoring

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March 2000

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FOYNES HARBOUR AND APPROACHES
CAPITAL DREDGING AND DISPOSAL

ARCHAEOLOGICAL MONITORING

Wessex Archaeology
March 2000
Ref: 47064

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prepared for

Michael Punch and Partners

on behalf of

Foynes Port Company

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FOYNES HARBOUR AND APPROACHES
CAPITAL DREDGING AND DISPOSAL

ARCHAEOLOGICAL MONITORING

Ref: 47064

Summary

Wessex Archaeology carried out archaeological monitoring of dredging works at Foynes Port, Limerick (NGR 1250 1520).

No material of archaeological interest was reported and no call outs were required. One monitoring visit was made on 24th February 2000. Recovered debris was confirmed as three modern sliding stock anchors, one very modern mooring anchor and a length of modern chain.

Of the three dredging methods employed, trailer suction dredging and ploughing provide very limited opportunities for identifying archaeological material. Backhoe dredging provides a slighty greater opportunity for identifying archaeological material in the course of recovery, but is used for specific purposes in restricted areas. The limited opportunity for identifying archaeological material by monitoring underlines the importance of thorough pre-construction investigations.

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FOYNES HARBOUR AND APPROACHES
CAPITAL DREDGING AND DISPOSAL

ARCHAEOLOGICAL MONITORING

Ref: 47064

Acknowledgements

Wessex Archaeology was commissioned by Michael Punch and Partners (MPP) on behalf of Foynes Port Company. We would like to thank Joe Murphy of MPP for his assistance.

Wessex Archaeology would also like to thank those engaged in the dredging works for their help, notably Colin Jackson (Hydrographic Surveys Ltd.), Ecko van Schaik (Terramare) and the staff of Irish Dredging Company Limited.

Archaeological monitoring was carried out by Kit Watson. This report was compiled by Kit Watson and Antony Firth. The project was managed for Wessex Archaeology by Antony Firth.

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FOYNES HARBOUR AND APPROACHES
CAPITAL DREDGING AND DISPOSAL

ARCHAEOLOGICAL MONITORING

Ref: 47064

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FOYNES HARBOUR AND APPROACHES
CAPITAL DREDGING AND DISPOSAL

ARCHAEOLOGICAL MONITORING

Ref: 47064

1. INTRODUCTION

1.1. PROJECT BACKGROUND

1.1.1. This document has been prepared by Wessex Archaeology in connection with capital dredging and disposal in the vicinity of Foynes Port (NGR 1250 1520) (Fig. 1) by Foynes Port Company (FPC). FPC is advised by Michael Punch and Partners (MPP), consulting engineers.

1.1.2. The works comprise dredging in the approaches to and within Foynes Inner Harbour, where silt, clay and rock are being removed generally to depths of –8.1 m and –12.0 m. Arisings from the dredging are being disposed of at two dump sites, North Dump and South Dump, within the main channel of the Shannon estuary. The Inner Harbour at Foynes has been subject to maintenance and capital dredging in the past, with arisings previously disposed of in the vicinity of the North Dump.

1.1.3. The capital works are subject to consent to dump at sea from the Department of Marine, which is advised on archaeological matters by Dúchas, the heritage service. Consent is subject to satisfactory provision for identifying archaeological material within the area of the works and for mitigating the effects of the works on such material.

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1.2. PRE-CONSTRUCTION INVESTIGATIONS

1.2.1. At the request of Dúchas, FPC commissioned Hydrographic Surveys Ltd. to carry out a geophysical investigation comprising magnetometer and sidescan surveys. Following discussion between the Hydrographic Surveys Ltd. and Dúchas, anomalies that warranted archaeological inspection were identified at seven locations.

1.2.2. Wessex Archaeology, in association with North East Diving Services Ltd, carried out the archaeological diving inspection in the vicinity of Foynes Port from 7 to 11 September 1999. The investigation was intended to facilitate decisions regarding any further investigation or mitigation that might be required prior to or in the course of development. Features which may reasonably be associated with each of the recorded anomalies were observed at the location of each anomaly. None of the observed features was of archaeological interest (see Wessex Archaeology September 1999, ref: 47062).

1.2.3. The report concluded, however, that there was still some scope for buried or otherwise unrecognised archaeological features to be present, and suggested that provision be made for archaeological observations during construction in the form of

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an intermittent watching brief and/or a call-out facility in the event of artefacts or structures being uncovered.

1.2.4. Accordingly, Wessex Archaeology was commissioned to carry out archaeological monitoring, the results of which are summarised below.

2. RESULTS OF MONITORING

2.1. DREDGING METHODOLOGY

2.1.1. The contract for capital dredging at Foynes was carried out by Irish Dredging Company Limited (a subsidiary of Westminister Dredging Company Limited). The predicted material to be dredged ranged from silt and boulder clay to rock (sandstone).

2.1.2. Dredging was carried out using both a trailer suction hopper dredger and a backhoe dredger supplemented by ploughing, with a blast and drill operation in advance of rock excavation (see Yell and Riddell 1995 for definitions).

2.1.3. The trailer suction hopper dredger was the *Medway II* (see Appendix A; Plate 1). It operated in the large areas of silt, lifting directly into its own hold and dumping via bottom doors onto the spoil ground. This method gives very little opportunity for recognising archaeological material that is smaller than the suction head (1.5m aperture), as any such material is removed within the volume of silt.

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2.1.4. The backhoe was the *Koura II* (see Appendix A) excavating into a separate hopper barge (see Plates 3-4). The backhoe method of dredging appears to give a slightly greater possibility of observing any archaeological material encountered during dredging works. However much of the area of operation of the *Koura II* appears to have been on deposits of little archaeological potential (rock or recent resilting).

2.1.5. A plough dredger, the *Barrow Sand* (see Appendix A; Plate 2), was also used to smooth out the seabed following the other dredging methods. As plough dredging does not raise any material to the surface its only potential for identifying deposits of archaeological interest is through snagging.

2.1.6. As part of the dredging contract it was stipulated that debris should be collected.

2.1.7. A small amount of additional diving work to check a propellor and damage to a buoy was carried out during the dredging works. Nothing of archaeological interest was reported.

2.2. RESULTS OF MONITORING

2.2.1. No material of archaeological interest was reported and no call outs were required. One monitoring visit was made on the 24th February by Kit Watson on behalf of Wessex Archaeology.

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2.2.2. *Medway II* had already completed its work by the time of the visit. *Kouros II* was carrying out maintenance dredging.

2.2.3. The monitoring visit took the form of discussions on the progress and results of the dredging works with Colin Jackson (Hydrographic Surveys, for FPC) and Ecko van Schaik (Terramare, for Irish Dredging).

2.2.4. Recovered debris was inspected onboard *Kouros II* and confirmed as three modern sliding stock anchors, one very modern mooring anchor and a length of modern chain.

3. CONCLUSIONS

3.1. Wessex Archaeology carried out archaeological monitoring of dredging works at Foynes Port, Limerick (NGR 1250 1520).

3.2. No material of archaeological interest was reported and no call outs were required. One monitoring visit was made on 24th February 2000. Recovered debris was confirmed as three modern sliding stock anchors, one very modern mooring anchor and a length of modern chain.

3.3. Of the three dredging methods employed, trailer suction dredging and ploughing provide very limited opportunities for identifying archaeological material. Backhoe dredging provides a slightly greater opportunity for observing archaeological material in the course of recovery, but is used for specific purposes in restricted areas. The limited opportunity for identifying archaeological material by monitoring underlines the importance of thorough pre-construction investigations.

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4. ARCHIVE

4.1. The project archive comprising paper, graphic and photographic records has been compiled under the project reference number 47064 and is currently held at the offices of Wessex Archaeology. The archive will be deposited on instruction from FPC in a suitable repository nominated by Dúchas.

5. REFERENCES

Wessex Archaeology, September 1999, Foynes Harbour and Approaches – Proposed Dredging and Disposal: archaeological diving inspection, unpublished client report, ref: 47062.

Yell, D. and Riddell, 1995, *Dredging: ICE design and practice guide*, Institution of Civil Engineers/Thomas Telford.

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APPENDIX A: DREDGER SPECIFICATIONS

Name	**Medway II**
Vesssel Type	Trailing suction hopper dredger
Built by	Verolme Shipyard, Heusden
Year of construction/major conversion	1976/1988
Classification	B.V. 13/3E Deep sea
Tonnage	3,122 GT / 1,034 NT
Length overall	77.09 m
Width	19.00 m
Moulded depth	6.30 m
Draught (empty)	3.41 m
(loaded)	5.81 m
Hopper capacity	3,683 m3
Carrying capacity	4,124 tons
Suction pipe diameter	1 x 0.80 m
Dredging depth	26.70 m
Discharge system	bottom doors/pump-ashore
Sailing speed	10.2 knots
Total installed power	4,620 kW
Sand pump output	866 kW
Jet pump output	827 kW
Pump overboard output	1,947 kW
Power during transport	2 x 1,082 kW
Power while dredging	2 x 1,082 kW
Bow thruster/propeller	1,060 kW
Features	Can work over 5 miles offshore
	Equipped with de-gassing installation and jet system

Name	**Koura II**
Vessel Type	Backhoe Dredger
Builder	Oy Navire Ab, Finland
Built	1977
Rebuilt	1989
Equipment	Demag H 185 A; bucket 4.5 / 8 cu.m
max. dredging depth	18 m
GRT	395 tons
Hull	Welded steel
Length overall	31 m
Width overall	14 m
Moulded depth	1.8 m
Port of Registry	Helsinki, Finland

Name	**Barrow Sand**
Vessel Type	Plough and Survey Vessel
Length	18.77 m
Width	6.71 m
Draught	1.55 m
NRT/GRT	53.00/79.00
Engines	2GM V8-71 total 500 hp
Propulsion	2 fixed propellors
Generator	GM3-71/21 KVA; 230V-AC 60AC
Speed	10 knots
Dreding depth	25 m
Ploughs available	Sand / silt / clay
Survey Equipment	Raytheon echosounder
	Autocarta system
	Trisponder positioning system

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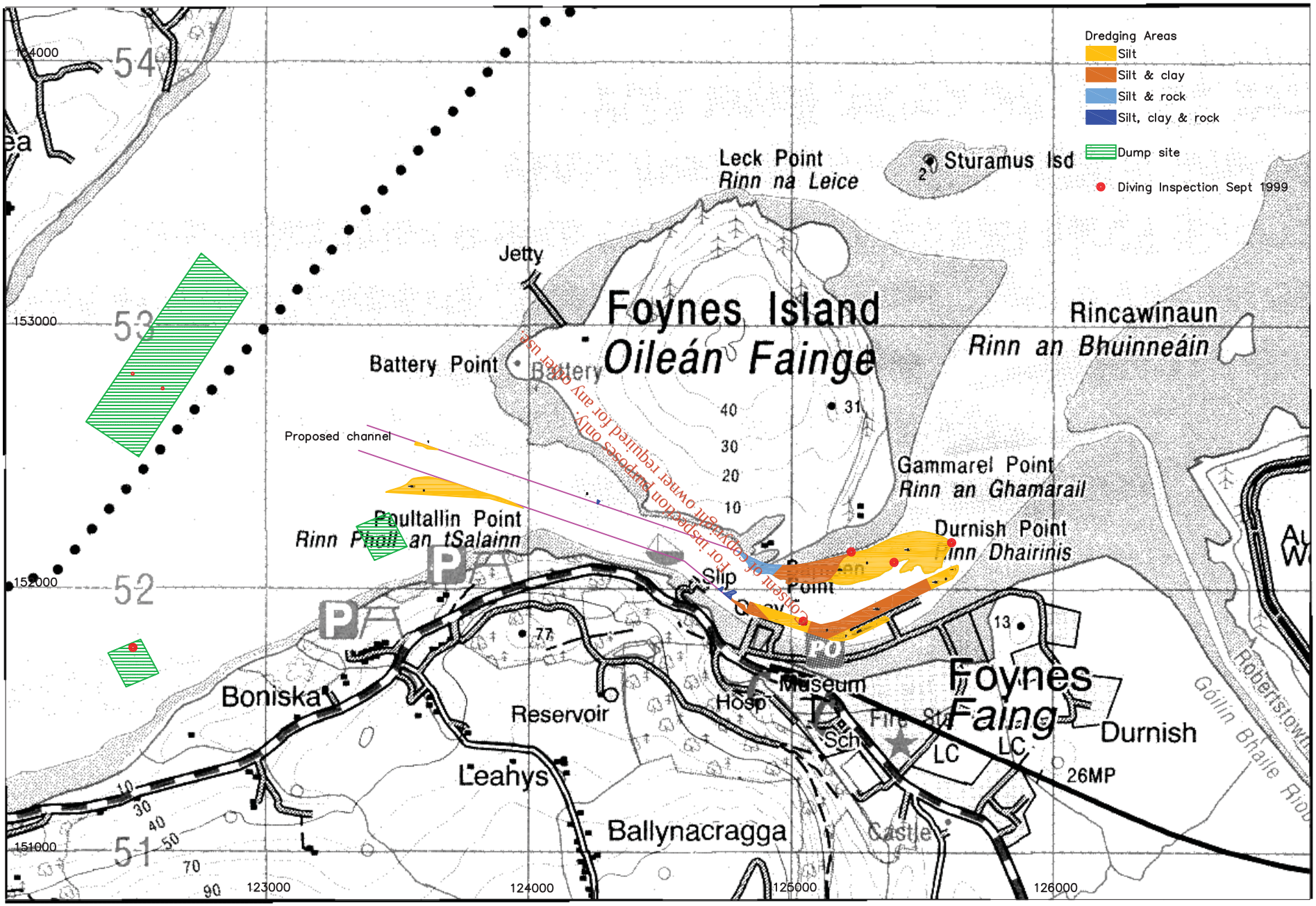


Figure 1

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Plate 1

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Plate 2

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Plate 3

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Plate 4

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Archaeological Monitoring, Maintenance Dredging, Foynes Port, Co. Limerick.



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Archaeological Monitoring conducted under The National Monuments Act 1930-1994:
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Client: Shannon Foynes Port Company

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BIBLOGRAPHY

APPENDIX A

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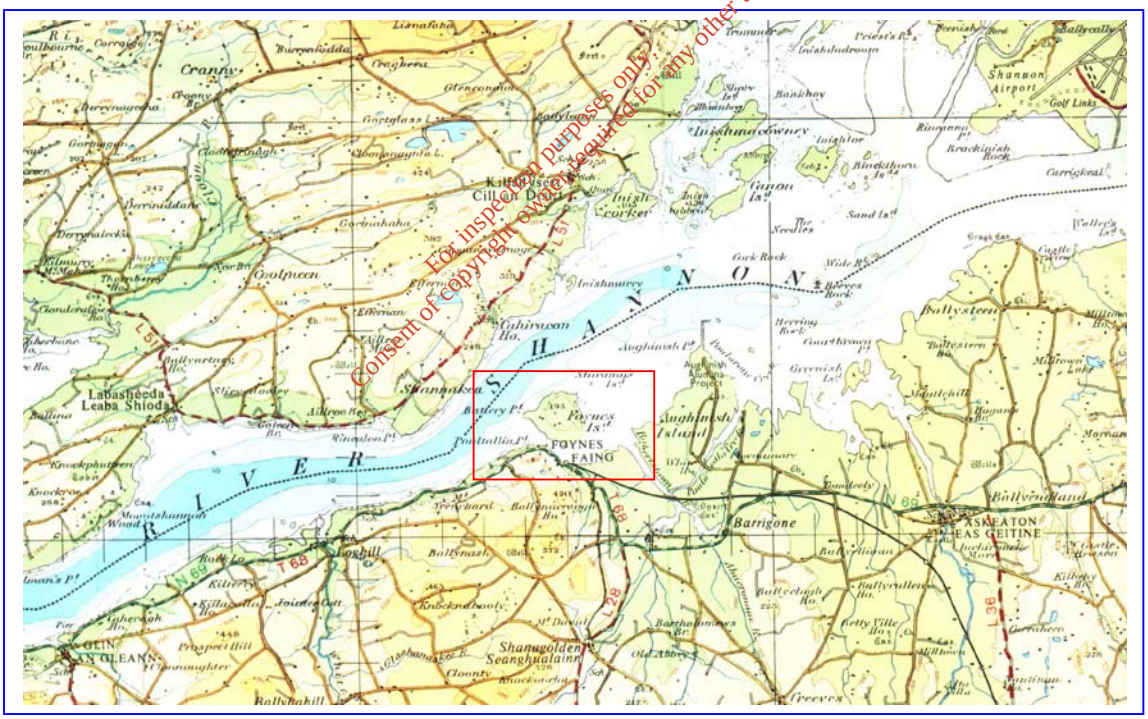
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1.0 INTRODUCTION

1.1 INTRODUCTION

Shannon Foynes Port Company commissioned *Boland Archaeological Services Ltd.* to conduct archaeological monitoring of berth and channel maintenance dredging operations at Foynes Port, Foynes, County Limerick. (Figure 1.1). The dredging operations and archaeological monitoring were conducted in December 2002, and the acquired data compiled in this report by BAS Ltd. during January 2003.

The monitoring was conducted under licence No 02E1767 issued to Mr Kieran Campbell Mr Kieran Campbell and Mr Donal Boland conducted monitoring of the dredging operations on a twenty four-hour basis



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Figure 1.1: Site location map

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1.2 THE SITE

The site of the dredging development is located at Foynes / Foynes Island, Foynes Port Co. Limerick (fig 1.1, 1.2 & 1.3).
Foynes / Foynes Island is in the parish of Robertstown, in the Shanid Division of the Barony of Lower Connello, County Limerick, and province of Munster.

The Town of Foynes is not recorded as being in existence when the roads of the area were recorded by Taylor and Skinner's in 1778. The Town is not recorded by Lewis in his topographical Dictionary of Ireland 1837.

Foynes Island four miles north from Shanagolden, near Lehy's Point, on the shore of the river Shannon. This place has been commended by Capt. Mudge, the Government engineer, as affording extensive and secure anchorage for shipping and consequently as a proper situation for the construction of docks and quays; at present it is seldom resorted by mariners, but the steamers plying between Limerick and Kilrush call on the Island to take up passengers. There was formally a battery of 24 guns on the island, erected for the protection of shipping and trade on the river. On the south side is a handsome marine villa, the summer residence of the Earl of Dunraven: and there are several neat cottage residences in different parts of the island/ (Lewis 1837, 634 - 635).

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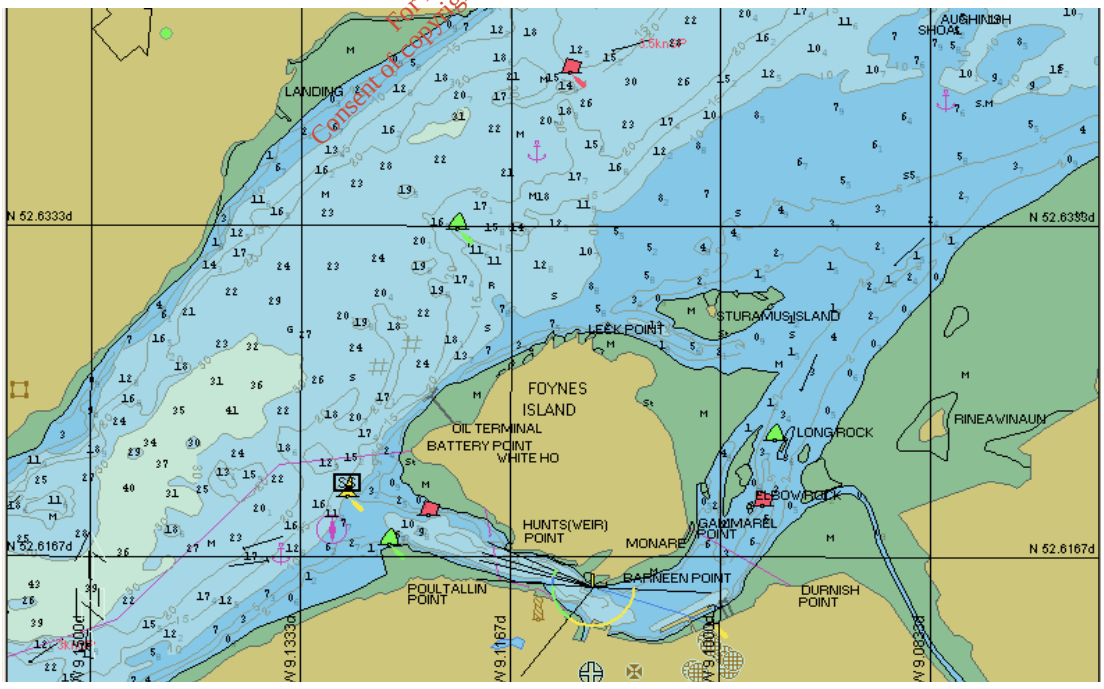


Figure 1.2: Site location chart.

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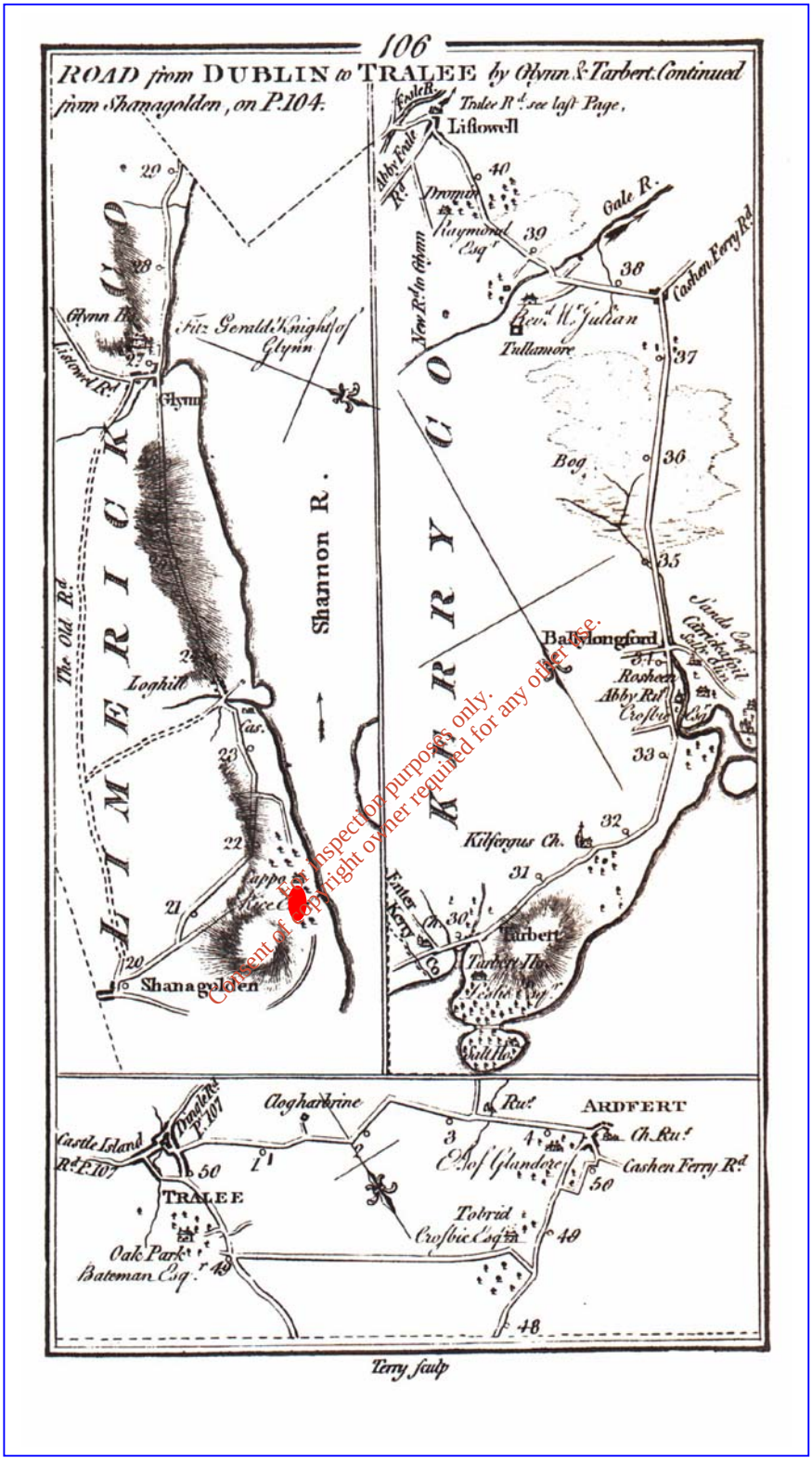


Figure 1.3: Road from Dublin to Tralee ,106.

Maps of the Roads of Ireland, Gorge Taylor and Andrew Skinner 1778.

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1.3 THE DEVELOPMENT

Foynes Port is affected by siltation, which it is deposited by the flooding tide. The extent of the siltation requires that the berths and turning area are dredged on an annual basis.

The port was dredged as part of a capital expansion programme in 1999 and maintenance dredging was conducted in 2001.

The extent of siltation over the past year has resulted in the limiting of vessel draft and a loss of revenue to the port.

The present dredging campaign entailed the use of a plough dredger, suction dredger and survey vessel.

Dredging operations took place at:

1. The west jetty
2. The face and back of the east jetty
3. The oil Jetty
4. The turning area
5. The entrance channel

The dredging operations were designed to remove only estuarine silts and debris, which had accumulated since the completion of the maintenance dredging campaign in 2001.

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1.4 ARCHAEOLOGICAL AND HISTORICAL BACKGROUND

1.4.1 Introduction

The following is a brief study of the historical and archaeological potential for marine archaeological sites in the Shannon Estuary and the vicinity of Foynes Port. In a wetland estuarine environment like the Shannon Estuary, boating would always have been one of the primary forms of communication and transport. While we have a detailed picture of the nature of this boat and shipping activity for the medieval and later periods, much of our image of earlier water based activity remains theoretical and speculative. Prehistoric communities which inhabited the fringes of the estuary must have made extensive use of dugout-canoes and other boat types. The discovery of a possible dugout at Carrigdirty Rock dating from the Mesolithic has been described earlier in this volume and other logboat finds from the Cashen and Fergus Estuaries have been well documented elsewhere. Wood may not have been the only source of boat building material and it is likely that people used whatever materials were at hand with which to build with. Wakeman refers to the use of reeds as a boat building material still in use in the early 19th century and which appears to have had a long period of usage prior to this (Wakeman 1873, 76). In the early part of the last century a reed craft was in use near Ely Lodge near Lough Erne. This vessel was built using wreaths of bull-rushes which were tied onto a frame or a raft made of rough branches of trees producing a composite wood and reed craft with the bull-rushes providing buoyancy and a water sealant for the craft. Other examples of this type of craft are known from around the country for use in fishing and ferrying and it must be plausible to suggest that reed craft were also used around the Estuary given the abundance of reeds which surround its shores.

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The use of skin-covered boats is well documented in the early texts. These boats with a light timber hull covered with skins, such as oxen hides are one of the most widespread and durable boat types throughout northwest Europe. The curraghs and naomhogs of the western seaboard represent modern survivors of this boat type that was certainly used in Britain and Ireland in late pre-historic times. Caesar, writing in the last century BC about one his campaigns in Spain in his *War Commentaries,* describes encountering difficulties in crossing a river. He directed his troops to 'build a number of boats, modelled on some that I have once seen in Britain. The keels and ribs were made of light timber; the rest of the hull was of wickerwork covered with hides' (Hope 1990, 11). Documentary evidence for the use of skin-covered boats in Ireland is contained in the 6th century AD Voyage tales of Brendan the Navigator (O'Meara 1991). Brendan's first voyage was carried out in a light vessel with wickerwork sides and ribs, which were covered with cowhide, tanned in oak bark, and tarred at the joints. Butter was carried onboard to dress the hides for repair. Much of Brendan's activities were based around the North Kerry area directly adjacent to the Shannon Estuary. The descriptions contained in the voyage tales must represent a common boat type of the region, one that has survived to the present day in the form of the curragh. The physical location and identification of such a boat from this period may prove elusive but it is important

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to realise that their character and form survive in contemporary boat traditions and these contemporary forms represent living archaeology, ancient boat types that have survived for centuries. Their survival represents the continuity of maritime traditions and shows how human adoption to coastal environments changes little over the centuries. It is also conceivable that plank and sewn boats may have been used in the Estuary during prehistoric and historic times. No evidence to substantiate this has yet been found but the recovery of these boat types from similar contexts in the Severn Estuary and elsewhere in England leaves this possibility open

With the coming of the Vikings to Ireland in the last decade of the 8th century boat traditions and forms were to witness radical new introductions. The slender clinker built, double ended dragon ships of the Vikings must have represented something that was both special and terrifying to the boatmen of the western seaboard. Limerick and the Shannon Estuary quickly attracted the newcomers to its shores given its strategic and economic importance. A Viking fleet and stronghold was established on these waters by the early part of the 9th century, which became a raiding base for much of the inland waterways of the country. In 843 the Vikings took Forannan, Primate of Armagh prisoner and carried him and his relics to their ships berthed at Limerick (*AFM*). Throughout the next two hundred years this fleet was active in raiding and conflicts all along the adjacent coast and waterways, particularly on the River Shannon. Native Irish fleets also appear to have been active. The *Annals of the Four Masters* refer to the fleets of Cormac and Flaithbheartach on the Shannon in 902 AD, while the *Annals of Innisfallen* refer to Donnchad, son of Brian, with the crew of one ship, coming upon a fleet of fourteen galleys on the Shannon in 1035 (*AI*).

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1.4.2 Medieval boats and ships

The coming of the Normans to Ireland in 1169 led to profound economic and social changes in the country. Mercantile activity greatly increased and the urban centres became successful ports entertaining ships from all over Europe. The protection of the ports and the safe passage of shipping to them was essential and special vessels called galleys were built to provide this security. Galleys were wooden clinker built double-ended boats which were powered by oars. They appear to have come in a number of different sizes and were very versatile and manoeuvrable craft. In 1205 King John had a fleet of 5 galleys based in Ireland, while two decades later Henry III mandated the men of Dublin, Waterford, Drogheda, Limerick and the other ports of Ireland, to build galleys in each of their ports for the defence of the Kings realm in Ireland in 1222 (*Cal. State Papers 1222, 18 July, 161*; McGrail 1993, 87). In 1234, 6 galleys were ordered to be built in Irish ports, two with sixty oars and four with forty oars. Seven years later the men of Drogheda were ordered to build a second galley to accompany their existing one while Waterford was to build two and Cork and Limerick one each (*Cal State Papers* 1241, 377, O'Neill 1987, 112). Bunratty, which appears to have acted as an outport to Limerick was also home to a number of galleys and is described in the early

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1300s as 'Bunratty of the wide roads, oared galleys and safe harbour' (Bradley u.d., unpublished Dúchas files).

The increase in mercantile activity led directly to the need for vessels with larger cargo carrying capacities. A ship type known as the cog emerged to cater for these needs, which must have been a common sight on the Estuary during the 14th and 15th centuries. These ships had a flat, flush laid bottom with a sharp bilge turn and were clinker built with iron spike fastenings attaching the planking to the frame. Straight raked stem and stern posts were the most distinctive feature of this new type of craft with the rounded ends of the older Scandinavian type of vessel being discarded. Cogs were fitted with one central mast with a large square sail fitted. Large after castles were built on the vessels in recognition of the security required for the cargo carried in an open cargo space in the centre of the hull, forward of the castle. These new trends in boat technology would quickly have spread and been adopted across Europe. The far larger carrying capacity of these cargo ships did not go un-noticed by enterprising Irish Merchants and mariners. The ports of the Shannon Estuary were no different and in 1338 Maurice, son of the Earl of Desmond hired the cog *La Rode cogge* that was based at Limerick for a journey to Gascony (O'Neill 1987, 111-2)

1.4.3 Late medieval and post-medieval shipping on the estuary

Profound changes in ship construction began to happen in early 15th century Europe (Gardiner 1994). Carvel construction, or the end to end joining of ships planking became the became the more common construction technique on larger craft but the clinker or overlapping technique continued to be used on smaller more localised boats. The Introduction of the carvel vessels meant that shipwrights could build larger vessels which were more structurally sound and more economical to build as less timber and manual labour was required during construction. Larger superstructures could also be accommodated on top of carvel hulls, which was particularly useful for military vessels. Carvel hulls could accommodate gun-ports which were particularly important as naval tactics increasingly depended on firepower. Two or three masts began to be added and fore and aft castles were merged into the hull of the vessel with the aft castle in particular becoming much larger and playing a more central role in the internal layout of the ship. By the middle of the 16th century hulls had become more rounded to increase stability and increase carrying space. Square sterns were added in order to support the superstructure and accommodate larger end rudders.

With the emergence of new ship building technology, Irish ports began to witness many new vessel types. The carrack, more than any other ship type epitomised this change. Although originally developed early in the 14th century in the Mediterranean, it quickly evolved and was adopted throughout North West Europe. Carracks were big heavy ships with large fore and aft castle structures. Initially they were rigged on the fore and main masts with single square sails

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but later they essentially became three masted ships. Evolutionary trends continued with the emergence of the galleon in the early part of the 16th century. Galleons differed from carracks in that had high narrow sterns with a lower forecastle and a low beakhead. This distinctive feature protruding from the hull below the bow sprit, a large spar extending from the stem of sailing vessels and used as a rigging support, was used for ramming and later provided a platform for handling headsails. Galleons also had a strongly braced hull adopted for almost continuous use in the strong Atlantic seas. There were many variants of this ship type throughout Europe with different regions displaying characteristics, which were adopted to suit local needs. Although primarily associated with a military or naval function, galleons were also frequently used for mercantile and fishing purposes. Much of the surviving evidence for these medieval ship types in Irish waters comes from the most famous naval episode in medieval European Maritime History, the Spanish Armada of 1588.

The Estuary was witness to the events of 1588 when a formidable Spanish Naval Armada attempted to defeat the English Navy and support an invasion attempt of England. The Armada was far from successful and following a humiliating defeat in the English Channel the Spanish vessels retreated home choosing the route around Scotland, down the western seaboard of Ireland and homewards to Spain. This retreat coincided with some of the worst sea storms on record and 26 Spanish ships, already badly damaged during the Channel engagement, were wrecked on the north and west Irish coasts. One vessel, the *Annunciada*, a 700 ton merchantman carrying 24 guns and 275 crew was burnt near Scattery Island and Kilrush. Nicholas Cahan, an official of the Sheriffs office at Liscannor reported at the time that seven armada ships had anchored off Carrigaholt (Whiting 1988, 200). Two 1,000 ton ships, two 400 ton ships and three barques had sent a boat ashore to try and bring on supplies but were refused. The Spanish offered the Annunciada as payment for any goods but this was refused (Stenuit 1972, 108). Weather conditions improved allowing the Spanish to leave after they had burnt the much damaged merchantman leaving Cahan to comment “God be praised, those seven ships are gone, but one ship they have burned” (Whiting 1988, 200). A document listed in the footnotes of the Annals of the Four Masters and located in the State Paper’s Office in London details the following - “Ships and men sunk, drowned or killed, and taken upon the coast of Ireland in the month of September, 1588, as followeth…in Shannan, one burnt, none lost, because the men were likewise embarked in other ships, signed Geff. Fenton.’ (*AFM*).

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Despite brief historical moments of excitement like the Armada the Estuary continued to be a focus of more mundane maritime economic activity. Attempts to improve transportation in the region utilising the estuary by the planters can for example be seen in correspondence between the Lord Deputy of Ireland, Sir Arthur Chichester, and the New English gentry of Askeaton in 1605 when a new ferry service across the upper Shannon estuary between Beagh and Rineanna was being proposed (*Cal. State Papers 1603-06*, 352-3; Feheney 1998,

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141). The 18th and 19th centuries were to see an intensification of maritime activity around the Estuary. There was a general increase in shipping and a proliferation of coastal industries which required waterfront facilities and vessels to transport their goods. Much of this increase in activity was due to individual entrepreneurs and landowners taking advantage of a more open economic system. It is from this later period that most of our information relating to wrecks and other maritime facilities are taken from.

1.4.4 Harbours and landing places

Boat and ship remains are only one component of the potential maritime cultural landscape of the study area. Harbours, small local piers and landing places are dotted around the Estuary and are an integral part of the cultural landscape. These sites were selected because they provided a safe and suitable place to bring boats ashore and granted shelter from the winds and prevailing weather conditions. They provided access to coastal settlement and defensive sites and provided access to the Estuaries hinterland. The probability is that they have been in use for many centuries given that a suitable landing place would have been repeatedly used. It follows then that a pier, while it may look modern, could be located on a site that has been in continuous use and might actually contain an earlier core within its modern form. It is this continuity of usage and repeated upgrading that has many led researchers to ignore their importance as cultural monuments. Yet for centuries they were the focal interchange points between the extensive hinterland and the foreland of the Estuary and the Eastern seaboard of Ireland as a whole. They provided a focus for fishing and industrial activities and their location often attracted and governed settlement patterns. Landing places were deemed particularly important within the study area given the extent of the mud-flats and the paucity of suitable places to bring a boat ashore.

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The Commissioners of Fisheries or the Irish Fisheries Board was established in 1819 in an attempt to organise the fishing Industry. They were primarily responsible for the administration of funds for pier and boat building while their engineers, including Alexander Nimmo, undertook coastal surveys and small-scale building projects (McDowell, 1964, 202). The Office of Public Works was established in 1831 by an Act of Parliament and took over much of the work of the Commissioners in finishing uncompleted piers and the repair of existing piers. They also became involved in navigation and were responsible for the erection of beacons and lights. A number of years previously in 1827 the Commissioners had spent £29,845 on pier construction and repairs including work on the piers at Carrigaholt and Dunbeg while an application for the construction of a pier at Querin in County Clare was also being considered (Brabazon 1848, 102). Querin, four miles from Carrigaholt, had been actively engaged in the fishing industry in the 18th and 19th century but lacked formal landing facilities. The Inspector of fisheries appeared hostile to the improvement of facilities here in the late 1820s (National Archive File O.P.W. 8/-297 Piers and Harbours) yet both the agents of the landlords and the local fishermen had volunteered contributions. (First Report 1836,

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224). Twenty-five fishing boats, of between seven to twelve tons, fourteen trading boats of forty to forty-five tons in weight, and about fifty small boats called 'canoes' operated out of the town and the owners of the boats each vouched to bring two loads of stone to assist in making a pier or quay in 1836 (ibid. 1836, 225)

1.4.5 Other maritime sites

The Discovery Programme has been involved in an extensive survey of foreshore sites on the Estuary over the last ten years. This has uncovered a wealth of sites on the inter-tidal flats. These surveys were concentrated in the Upper Estuary area with little survey work being undertaken in the area of the proposed development. However, given the extent of material found in the Upper Shannon area it is likely that similar findings will be made in the vicinity of Foynes. These could include palaeo-environmental features, fish-traps, submerged settlement and boat finds.

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1.5 SHIPWRECKS LISTED FOR THE SHANNON ESTURARY

1.5.1 Co.Kerry

Source: Historic Shipwrecks on the Shannon Estuary, **Co. Kerry**. Dúchas, The Heritage Service.

NAME	DATE	LOCATION	DETAILS
Brittania	8 Nov. 1825	Between Tarbert and Glynn	Vessel of Rothsay
Diana	6 Feb. 1820	Near Tarbert	London to Limerick
Llanthewy/Llanthenry	27 Dec. 1902	Beale Bar	Iron steamship of Newport
Margaret	6 Jan. 1818	Mouth of River Shannon	Liverpool to Limerick
Premier	26 Oct./Nov. 1898	Between Beale Bar and Kilcreadine light	537 ton steel steamer. Cargo of sugar.
Quereda	27 Jan 1834	Off Carrig Island	Vessel of Sunderland. Limerick to London.
Thetis	30 Nov. 1834	Beale Bar	En route to Limerick. Wreck site is marked on the 1921 OS 6" map, Sheet 1.
Unknown	Nov. 1839	The Beeves	None
Unknown	15 Aug. 1893	Off Tarbert	18 ft. rowing vessel.
Unknown	10 Sept. 1903	Beale Point	'Canoe'.
Unknown	9 Feb. 1904	Tarbert Roads	Unregistered iron lighter of 12 tons.

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1.5.2 Co. Clare

Source: Historic Shipwrecks on the Shannon Estuary, **Co. Clare**. Dúchas, The Heritage Service.

NAME	DATE	LOCATION	DETAILS
Agenoria	28 Jan. 1847	Kilrush	117 ton sailing vessel
Albion	6 Jan. 1839	Labasheeda Bay	
Alice	30 Mar. 1814	In the Shannon	Limerick to Liverpool.
Alice & James	10 Dec. 1826	Scarlet Rocks, River Shannon	Limerick to Liverpool.
Anna Belle	21 Nov. 1881	Boland Bay, Kilrush	Wooden brigantine, 153 tons. Limerick to Penarth/Penrith. Cargo of oats.
Anne	27 Jan. 1847	Kilrush	161 ton sailing vessel.
Annunciada	1588	Scattery Island/Carngholt	700 ton Ragusan Armada ship. Burnt and sank.
Atlanta	17 Mar. 1836	Dunaha	Brig.
Bridgewater	6 Jan. 1818	Mouth of the Shannon	Sligo to London.
Calpe	13 Nov. 1847	Kilrush	104 ton sailing vessel.
Carolinea	27 Jan. 1847	Kilrush	Sailing vessel.
Catherine	4 Nov. 1849	In the Shannon	Limerick to Liverpool.
Charity	1839	Labasheeda Bay	
Cicero	1833	On the River Shannon	434 ton vessel.
Ciro	27 Jan. 1847	Kilrush	
Commerce	5 Apr. 1791	Entrance to Limerick River	Philadelphia to Dublin
Daniel O'Donnell	6 Jan. 1839	Near Limerick	
Defiance	1835	In the Shannon	35 ton.
Ed	28 Jan. 1847	Kilrush	142 ton
E.D.J.	1940/1941	Islevaroo, near Kilrush	Motor vessel. Kilrush to Limerick with turf. Sold for scrap.
Eleanor	29 Dec. 1823	Labasheda	Limerick to Liverpool.
Eliza	20 Jan. 1821	Kilrush	Trinidad to Cork.
Eliza	8 Feb. 1822	Near Kilrush	Limerick to Swansea
Eliza	24 Dec. 1852	Rocks in Scattery Roads	59 ton schooner. Sligo to London. Cargo of meal.
Eliza and Ann	27 Jan. 1847	Kilrush	Limerick to Liverpool.
Elizabeth	27 Jan. 1847	Kilrush	
Elizabeth and Mary	13 Jan. 1843	In the Shannon	Limerick to Liverpool.
Esther	18 Mar. 1854	At sea – put into Kilrush	Newport to New York. Cargo of iron.
Flora	16 Jan. 1818	Mouth of the Shannon	Quebec to London
Fowey	1 Aug. 1813	Kilbaha	Limerick to Plymouth. Cargo of Pork.
Friendship	27 Jan. 1847	Kilrush	94 ton vessel
Garryone	6 Jan. 1839	Beach at Kilrush	Steamer
Georgina	9 May 1884	On the Shannon	Schooner. Collided with SS Vale.
Glencoe	27 Jan. 1847	Kilrush	155 ton vessel.
Grecian	6 Jan. 1839	Kilrush	
Hamilton	6 Jan 1839	Kilrush	Revenue Cruiser

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Helen	28 Dec. 1894	Scattery Island	Iron barque. Cargo of grain
Henry and Anne	c. 20 Nov. 1850	Island opposite Kilrush	
Hepzibah	1 Oct. 1912	Kilcredane, Carrigaholt	90 ton schooner. Kilrush to Aran, in ballast.
Hope	20 Jan. 1821	Kilrush or Loop Head	London to Limerick
Isabella	6 Jan. 1839	Labasheeda Bay	
John	1 Dec. 1825	Mouth of the Shannon	Dublin to Limerick
Lamb	12 Apr. 1751	Kilrush	
Lark	28 Jan. 1803	In the Shannon	Fishing boat
Maas	27 Jan. 1847	Kilrush	
Margaret	6 Jan. 1818	Mouth of the Shannon	Liverpool to Limerick
Mary	24 Dec. 1811	In the Shannon	Limerick to London
Mary	13 Nov. 1908	Off Querrin	Wood and canvas canoe for fishing.
Mary Ann	5 Dec. 1817	Kilrush	Limerick to Galway
Mary Collins	8 Dec. 1817	Cappa, near Kilrush	Limerick to Galway. Cargo Laugh stone.
Mary of Milford	1875	Boland Rocks, Kilrush	75 ton schooner
Myrtle	1828	In the Shannon	100 ton vessel.
Perseverance	3 Dec. 1820	Kilrush	Pernambuco to Liverpool.
Prudence	31 Mar. 1818	Into the Shannon	Portuguese schooner. St. Ubes to Limerick.
Rebecca	9 Apr. 1853	Kilrush – damaged and discharged	Newport to New York. Cargo iron.
Spilling Rock	7 Oct. 1889	Shannon region	
Treenaglass	1 Aug. 1833	Bridges Bank, near Palaskenry	1513 ton steamer. Cargo maize.
Triumph	1 Aug. 1851	Off Hog Is., Kilrush	America to Limerick.
Union	15 Jan. 1819	Labasheeda	Limerick to London
United Kingdom	24 Jan. 1834	Kilrush	Galway to London
Venus	12 Dec. 1818	Labasheeda	Limerick to London
Venus	22 May 1890	Near Beeves Rock LH	60 ton wooden smack. Kilrush to Limerick. Cargo turf.
Victoria	4 Nov. 1853	In the Shannon	100 ton schooner. Limerick to London. Cargo oats.
Vietury	18 Jan. 1805	Kilrush	Limerick to London
Welcome	6 Jan. 1839	Labasheeda Bay	
Wentworth Beaumont/Wentworth	30 Sept. 1873	Carrigaholt	254 ton brig. Limerick to Shields in ballast.
William Ash	17 Nov. 1851	Hog's Head Rock	
Unknown	14 Nov. 1690	Mouth of the Shannon	French Frigate.
Unknown	4 Nov. 1691	River Shannon	French 'logboat'.
Unknown	12 Aug. 1788	Near Foynes Island	
Unknown	20 Nov. 1816	Whelp Rock, River Shannon	Large sail boat
Unknown	Feb. 1826	Kibaha Bay	
Unknown	18 Feb. 1826	Kibaha, Loop Head	
Unknown	c. 20 Nov. 1850	Between Kilrush and Tarbert	Ferry boat. Kilrush to Tarbert.
Unknown	6 Jan. 1839	Near Limerick	
Unknown	1 Jan. 1871	Carrigaholt	'Canoe'
Unknown	Feb. 1903	Near Carrigaholt	

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1.5.3 Co. Limerick

Source: Historic Shipwrecks on the Shannon Estuary, **Co. Limerick**. Dúchas, The Heritage Service.

NAME	DATE	LOCATION	DETAILS
Adeona	18 Jan. 1825	Hogshead Rocks, R. Shannon	Limerick to Liverpool.
Aid	24 Dec. 1852	Tarbert Road	Got off.
Astrea	Jun. 1834	Limerick	
British Queen	2 Feb. 1847	Limerick	
Cassandra	7 Jan. 1794	20 leagues from Limerick	St Ubes to Limerick
Castleragget	Oct. 1833	Foynes Is.	Turf boat. Limerick to Ballylongford. Collided with a brig near Foynes Island.
Colombus	4/5 Dec. 1851	Harold Rock	Odessa to Limerick.
Dorothy	20 Nov. 1851	Limerick	Limerick to London. Cargo oats.
Edgecumbe	21 Dec. 1854	Beal Bay	108 ton brig. St. John's NB to Limerick. Cargo deals.
Elanor	Dec. 1832	Limerick	400 ton vessel.
Elentheria	6 Feb. 1847	Limerick	
Eliza	Dec. 1759	Limerick Haven	London to Limerick.
Flora	Sept. 1802	Near Limerick	Vessel of Greenock.
Hannah	22 Jan. 1747	Near Limerick	Newfoundland to Limerick.
Helena and Mary Hegarty	Dec. 1785	Cratsoe	Vessel of Jamaica.
Heroine	24 Dec. 1852	Limerick	374 ton barque.
Jessy	10 Nov. 1851	Meelick	Quebec to Limerick.
Liverpool	8 Nov. 1825	Between Tarbert and Glynn	Vessel of Liverpool.
Louis Eleonie	24 Apr. 1852	Limerick	Tampico to Harvre.
Maid of the Mist	10 Mar. 1847	Limerick	
Medusa	19 Nov. 1850	Limerick Harbour	310 ton brig. Cargo wheat.
Minerva	17 Dec. 1829	Shannon River	86 ton schooner. Cargo oats and butter.
Osprey	8 Sept. 1851	Between Tarbert and Glin	Swansea to Limerick.
Peggy	Dec. 1790	Limerick River	Limerick to Greenock.
Premier	26 Nov. 1898	Between Kilcredane Light and Beal Bar Buoy	196 ton steel steamship. Hamburg to Limerick. Cargo sugar.
Solidade	28 Dec. 1781	Limerick River	Lisbon to Waterford.
Thrasher	16 Aug. 1892	River Shannon	40 ton wooden smack. Burnt at Limerick.
Topaz	28 Dec. 1900	1 mile below Glin Pier	196 ton brigantine. Cargo wood.
Venus	1890	River Shannon	Derelict smack.

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Witte Leeuw	10 Jan. 1849	Off Limerick	Rotterdam to Limerick.
York	Nov. 1758	Near Limerick	Bombay to Limerick.
Unknown	Dec. 1630	Limerick/R. Shannon	Spanish carvel. Cargo fish and salt.
Unknown	Jun. 1832	Between Monsells Creek and Ballincurra Creek	Open sail boat.
Unknown	Feb. 1833	Kerry Head, River Shannon	Brig. Cargo salt.
Unknown	Nov. 1850	The River, Limerick	Smack.
Unknown	Nov. 1850	The river, Limerick	Smack.
Unknown	25 Dec. 1852	Limerick	Brig. Cargo oats.
Unknown	6 Aug. 1905	Muckinish Strait	2 ton pleasure boat (sail).

1.5.4 Sources of information

Historical research has shown that at least 127 vessels are recorded as having being lost in the Shannon Estuary from the 16th through to the early 20th century AD. Documentary evidence for wreck is heavily biased towards the post-medieval period but this is related to the nature of the inventory sources rather than the actual wreck resource itself. Recording of ship loss was only initiated in the 1740s, by Lloyds the insurance and shipping company in London, when the extent of wrecking began to have a detrimental effect on the British economy as it was heavily dependant on maritime trade and communications. Systematic recording only began in the middle of the 19th century reflecting the more humanitarian society that was emerging at that time and concern for the loss of life at sea. The negative impact of shipping loss on the economy remained however the over-riding concern. This is reflected in the fact that it was the British Board of Trade who published the annual lists of shipping loss after 1850 rather than a life saving organisation like the lifeboat society. These annual lists published by the House of Commons coupled with the accounts of shipping loss published in Lloyd's List, the bi-weekly newsletter produced by Lloyds, form the basis of the documentary record for wreck in Ireland. These sources were usually only concerned with larger vessels and rarely mention the loss of smaller local craft, engaged in fishing or used for leisure purposes. Local and National newspaper accounts are valuable sources for these vessels and tend to give a more accurate and localised version of the loss than what was being produced and recorded by civil servants in London acting on second hand information.

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Accounts of incidents of wreck from the period prior to 1740 are more difficult to access. There was no systematic recording of wreck loss in the medieval period and researchers are dependant on a number of passing references to wrecking in the known medieval texts. Most of the few-recorded losses in these texts refer to major political events such as the wrecks of the ill-fated Spanish Armada of 1588 or to the loss of large merchant vessels. There are also a number of references of instances of litigation in relation to the ownership of wreck material that had been salvaged or washed up on the coast. The Earlier Annalistical sources from the

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Early Historic period are also useful in detailing the use and loss of a number of Viking and native Irish fleets and boats but these may be exaggerated accounts and are unreliable. The wreck inventory must therefore be treated with caution as a true reflector of the extent of wreck loss given its inherent bias towards the later period and the other limitations it contains. Many other vessels were undoubtedly lost around the Shannon maritime region. Shipping and boat loss was not simply a product of the post-medieval period but has occurred since the earliest occupation of the region and continues to the present day. 127 vessels lost since 1588 is a large number of wrecks but a truer figure may be closer to 500 lost since prehistoric times.

1.5.5 Date of loss

Of the 127 wrecks recorded in the Estuary over 90% were lost in the 19th century, 8% were lost in the 18th century with the remainder being 'cast away' in the 15th, 16th and 20th centuries. Instances of logboat finds are not included as wreck loss in the inventory and there is no known example of prehistoric or early historic wreck loss in the region. This of course is not to say that such sites are not present, but rather that they have not been recorded in the historical record. The earliest recorded loss is the 1588 Armada vessel, burnt near Scattery Roads while the last vessel in the inventory is the loss of a motor vessel in 1941. 1945 has been taken as the cut-off date for the inventory to include the many important World War I & II losses. Interestingly though the 1941 wreck is the only Wartime loss recorded for the Estuary. This corresponds sharply with the large number of vessels lost in the Irish Sea and North Channel areas during the wars, two strategically and economically important marine areas during these periods of conflict. The vast majority of the vessels lost in the area were wooden vessels from the age of sail, dependant solely on the power of wind for their propulsion. A radical change in ship technology occurred in the middle of the 19th century when ships increasingly began to be built of iron and were dependant on steam and engines for propulsion. This led to much improved safety records and shipping loss began to decrease rapidly, with the obvious exception of war loss.

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1.5.6 Reasons for loss

There were many reasons why a vessel is lost at sea. Conflict, human error and poor equipment have all been factors in loss but it is probably weather which is the greatest cause of loss. Over 80% of the vessels wrecked in the Estuary were lost as a direct result of bad weather conditions and more specifically high winds with gales resulting in rough seas. In a relatively enclosed area like the upper reaches of the Estuary sailing vessels are at mercy of the wind and seas once the weather turns bad. In open seas ships will normally be able to run with the seas and weather out a storm but in estuaries and enclosed bays there is usually nowhere to run. It is unsurprising then that 48 of the vessels listed as lost are described as having 'run ashore'. This type of loss has implications for the preservation of wrecks on the foreshore. Being stranded they would have been exposed to immediate salvage attempts by

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their crew and by local people. In the event that the boat could not be re-floated it would then have been stripped and possibly burnt to the waterline to prevent it from being a hazard to navigation. The remains of many of these hulks are dotted around the Estuary and manifest themselves as little more than the lowermost portion of hull planking possibly encased with stone ballast mounds. A further 18 vessels were lost as a direct result of the weather but it is not clear in a number of cases whether these were lost in open water or on the coast. One of the interesting things that come out of the wreck data is that there appears to be a direct correlation between loss and intense episodes of bad weather. This data can then be used as an indicator of climatic events and can be used to support other sources of climatic data in researching past weather patterns and specific events. There are a number of marked peaks in the Estuary wreck data centred around the years 1836/37 and the early to middle 1840s. Interestingly this appears to coincide with the period of the famine and a number of the episodes that are commonly referred to in folklore as the nights of the big winds.

1.5.7 Location of losses

Eight vessels are listed as foundering in the open water within the main body of the Estuary. These sites are likely to be more structurally intact than foreshore examples. The bottom mud of the Estuary can be many metres deep and a vessel that was deposited into this environment during the course of a catastrophic wrecking incident would quickly become sealed, ensuring good preservation. However while the deep mud will provide an anaerobic environment suitable for good site preservation, the actual physical location of these sites is extremely difficult. For the most part location is dependant on chance finds by fishermen, finds made during dredging work or through the deployment of marine geophysical survey equipment in targeted survey areas.

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2.0 MONOTORING OF DREDGING OPERATIONS

2.1 ARCHAEOLOGICAL MONITERING DESIGN.

Dredging operations have been conducted at the port of Foynes in 1999 and 2001 the dredging operations were not monitored for the presence of archaeological material.

Duchas required that the dredging campaign beginning planned for 2002 be assessed and initially monitored for the presence of archaeological materials.

The dredging design entailed the deployment of a suction dredger assisted by a plough dredger with continuos monitoring of the dredging progress by way of bathmetric survey.

The plough dredger was designed to drag material from areas which were inaccessible to the larger suction dredger to locations where it could be accessed and to level out small high points which remained following the passage of the suction dredger.

The suction dredger was designed to operate as a large vacuum cleaner the head of which trailed along the riverbed sucking up the soft, transient, silty mud and accumulated debris.

The ports pilot launch was fitted out to conduct bathemetric surveys and to provide feedback as to the progress of the dredging operation.

All dredging operations were designed to operate on a twenty four-hour basis for a period of approximately two weeks.

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As the plough dredger commenced operations prior to the arrival of the suction dredger it was agreed with Duchas that the plough dredging operations would be monitored continuously for a twenty four hour period and the results of monitoring to be assessed to determine if further monitoring was required.

The suction dredger would be monitored continuously for a five-day period and the results of monitoring to be assessed to determine if further monitoring was required.

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Figure 2.1.1 The archaeological director Mr Kieran Campbell assessing the site prior to the commencement of monitoring procedures.

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Figure 2.1.2 The effect of siltation adjacent to the east jetty, imaged at a period of low water

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2.2 ARCHAEOLOGICAL MONITORING OF PLOUGH DREDGING OPERATIONS

Archaeological monitoring of the plough dredging operations commenced on Friday the 6th December and terminated on Saturday the 7th.

The plough dredging was conducted by the vessel *Tioga B* pulling a large flat bottomed plough (fig 2.2.3-4), which had the effect of pulling a thin layer of mud for a maximum distance of 150m.

Ploughing operations were conducted directly adjacent to the east and west jetties (fig 2.2.1). The ploughing vessel traversed backwards and forwards along the face of the jetty dragging material from the face of the jetty towards a depression in the riverbed or to a location where it could be accessed easily by the suction dredger.

Monitoring of the dredging procedure was readily achieved from a position on the jetty at which the dredger was operating.

During the hours of darkness monitoring was achieved by way of a night vision viewer assisted by the illumination of the site by the jetty lighting system (fig 2.2.2).

The plough dredge was operated continuously below the water level being only lifted slightly when not in ploughing mode.

Each dredging cycle extended for a period of two minutes with approximately 720 cycles monitored during the twenty four hour period.

Close attention was paid to the plough and the wake of the vessel during the ploughing procedure, but no materials were seen to be liberated and float to the surface.

The riverbed adjacent to the ploughing zone was inspected at periods of low water, but no material of an archaeological nature was observed.

Monitoring of the plough dredging operations was discontinued after the initial twenty four hour period based on the results of monitoring and discussions with Duchas Maritime Unit.

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Figure 2.2.1 Day time ploughing operations adjacent to the east jetty

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Figure 2.2.2 Night time ploughing operations adjacent to the west jetty

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Figure 2.2.3 The plough in the raised position at the stern of the *Tioga B*



Figure 2.2.4 The plough blade

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2.2 ARCHAEOLOGICAL MONITORING OF SOCTION DREDGING OPERATIONS

Archaeological monitoring of suction dredging operations commenced on Tuesday the 10th December and terminated on Saturday the 14th.

The suction dredging operations were conducted by the vessel *Medway II* a bottom opening suction hopper dredger.

Suction dredging operations were conducted in all areas (see section 1.3).
Monitoring of the dredging procedure was readily achieved by inspection of the dredge head on completion of each dredging cycle. During the hours of darkness the dredge head was illuminated by the vessels lighting system.

Material extracted from the dredge head was first placed in a tray below the head where it could be investigated prior to its placement in an open skip.

The suction dredger operated continuously, dredging the berths and turning basin. At the end of each dredging cycle (when the hold of the dredger was full) the dredger departed the port for to discharge the dredged material in a deep area of the estuary opposite the entrance to the port.

Each dredging cycle extended for a period of two hours with sixty one cycles monitored during the five day period.

Close attention was paid to the dredge head and its wake during the dredging procedure, but no archaeological materials were recovered from the dredge head or were seen to be liberated and float to the surface.

Monitoring of the plough dredging operations was discontinued after the initial five day period based on the results of monitoring and discussions with Duchas Maritime Unit.

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Figure 2.3.1 The suction dredger Medway II

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Figure 2.3.2 The dredge head and material retention area.

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Figure 2.3.3 The hold of the dredger which contained the dredged materials.

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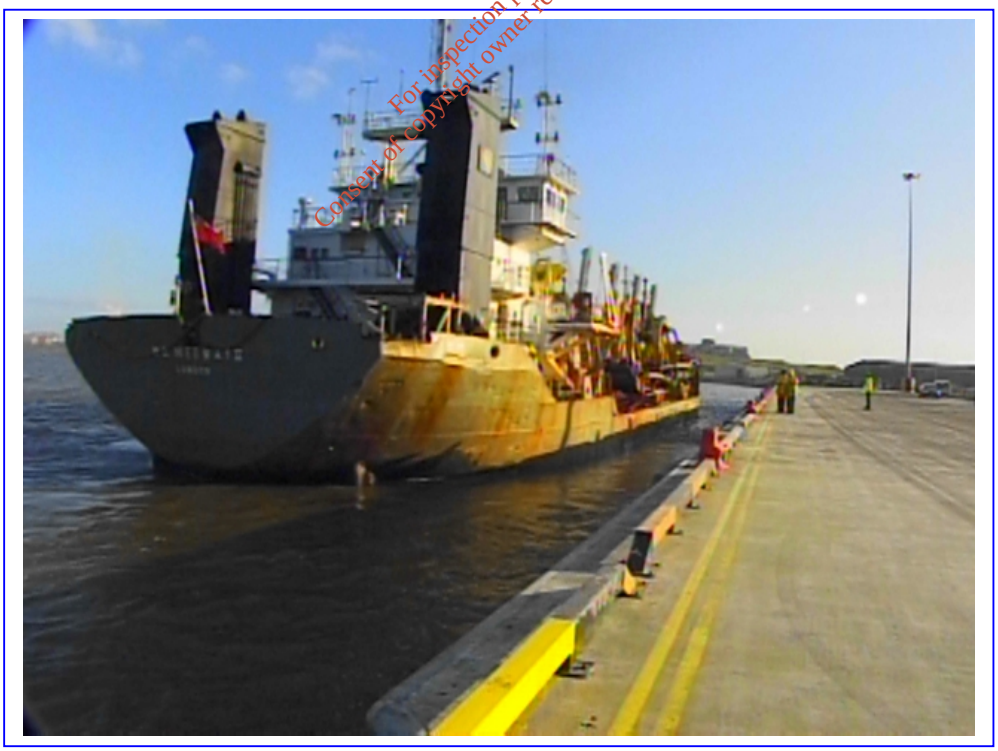


Figure 2.3.4 The suction dredger Medway II dredging adjacent to the west jetty

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Figure 2.3.5 Finds in finds tray, typical for site

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Figure 2.3.5 A ships timber located on the back deck of the dredger, reported to have been dredged up adjacent to the famous Mary Rose site.

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3. RESULTS OF MONITORING

3.1 FINDS FROM DREDGING

- No finds were retrieved from the monitoring of the plough dredging operation.
- Finds retrieved from the suction dredging operation were of modern manufacture.
- No finds of archaeological importance were located by the monitoring procedures set in place to monitor the maintenance dredging of Foynes Port.

3.1 FINDS FROM VESSEL

Three ships timbers located on the back deck of the suction dredger Medway II were reported as having come from a site adjacent to the Maryrose site. Other timbers which had been retrieved at the same location were collected by members of the Maryrose Trust, but these three were left behind. Following discussions with Duchas the timbers were removed for transportation to the Maryrose Trust.

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3.2 CONCLUSIONS

1. Monitoring of capital or initial dredging operations is a valid methodology for the retrieval of archaeological materials and the location of archaeological sites.
2. The monitoring of maintenance dredging operations particularly second and third generation dredging is not as valid.
3. The monitoring procedures adopted to monitor the maintenance dredging operations at Foynes port located no archaeological materials.

3.3 RECOMMENDATIONS

1. Maintenance dredging operations at Foynes Port should not be subject to archaeological monitoring in the future.

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Appendix A

Finds Log Foynes Port 2002

Cycle No.	Area Dredged	Finds	Disposal Location
1	Turning Area	Stone	122619.1E 152758.5N
2	Turning Area	Clear	122637.4E 152760.8N
3	Turning Area	Plastic & Rocks	122520.2E 152769.3N
4	Turning Area	Clear	122609.5E 152889.4N
5	Turning Area	Clear	122575.6E 152870.5N
6	Turning Area	Clear	122619.7E 152870.3N
7	Turning Area	Clear	122663.9E 152940.4N
8	Turning Area	Clear	122613.0E 152716.4N
9	West Jetty	Plastic sheet	122592.5E 152770.7N
10	West Jetty	Clear	122576.3E 152710.2N
11	West Jetty	Clear	122552.4E 1527690.1N
12	West Jetty	Copper Wire c.2m	122573.4E 152665.0N
13	West Jetty	Clear	122645.6E 152907.4N
14	West Jetty	Clear	122616.1E 152936.5N
15	West Jetty	Clear	122574.1E 152758.8N
16	West & East Jetty	Branch & Plastic	122331.3E 152902.2N
17	West Jetty	Rubber Fender c.3m	122539.1E 152721.6N
18	West Jetty	Metal Pipe & Plastic	122579.4E 152732.9N
19	West Jetty	Stones	122656.7E 152772.8N
20	West Jetty	Clear	122580.5E 152806.0N
21	Turning Area	Stone	122591,3E 152781.3N
22	West Jetty	Clear	122532.4E 152808.8N
23	West Jetty	Piece of Canvas	122595.7E 152938.0N
24	West & East Jetty	Clear	122739.4E 152935.1N
25	East Jetty	Clear	122474.2E 152793.3N
26	East Jetty	Clear	122614.2E 152751.0N
27	East Jetty	Wire	122541.9E 152617.7N
28	East Jetty	Plastic	122652.6E 152786.3N
29	West & East Jetty	Clear	122613.5E 152875.1N
30	West & East Jetty	Clear	122641.9E 152898.2N
31	West & East Jetty	Tyre, Chain, Branch	122599.5E 152897.5N
32	East Jetty	Plastic Sack	122581.3E 152837.9N
33	East Jetty	Clear	122652.9E 152902.0N
34	East Jetty	Plastic Sack	122657.3E 152851.8N
35	East Jetty	Clear	122622.5E 152764.0N
36	East Jetty	Stone	122566.6E 152824.3N
37	East Jetty	Cable	122591.7E 152785.8N
38	East Jetty	Clear	122584.8E 152702.8N
39	East Jetty	Length of Wire	122610.0E 152722.3N
40	East Jetty	Clear	122557.4E 152689.2N
41	Entrance Channel	Clear	122643.0E 152956.0N
42	East Jetty	Clear	122616.1E 152801.1N
43	East Jetty	Clear	122529.4E 152774.8N
44	East Jetty	Clear	122517.9E 152820.0N
45	East Jetty	Clear	122589.6E 152720.2N

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46	East Jetty	Stone	122538.2E 152911.1N
47	East Jetty	Wire c.2m	122665.6E 152891.0N
48	East Jetty	Plastic & Stone	122664.2E 153044.2N
49	East Jetty	Clear	122618.9E 152987.5N
50	East Jetty	Plastic & Rope	122522.1E 152906.5N
51	East Jetty	Clear	122542,7E 152800.6N
52	East Jetty	Clear	122632.5E 152890.9N
53	West & East Jetty	Clear	122598.9E 152797.3N
54	Entrance & East Jetty	Clear	122621.2E 152938.1N
55	Entrance & West Jetty	Coal Sack & Stone	122599.5E 152838.3N
56	Entrance & West Jetty	Wire	122602.6E 152800.1N
57	Entrance & West Jetty	Clear	122547.9E 152836.5N
58	Oil Berth	Clear	122561.7E 152780.0N
59	West & East Jetty	Clear	122502.2E 152816.7N
60	Entrance & West Jetty	Plastic & Stone	122598.8E 152897.9N
61	Turning Area	Clear	122708.9E 152992.5N

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SECTION 7

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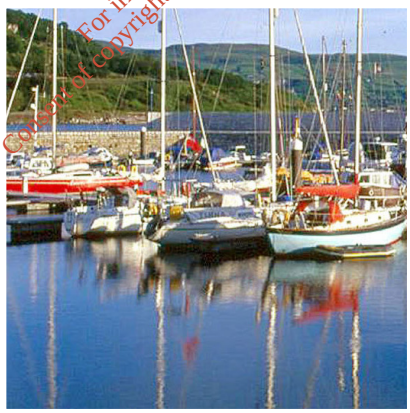
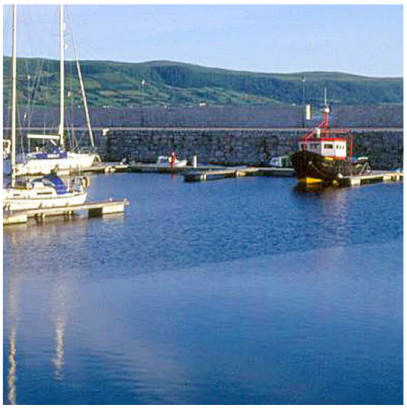
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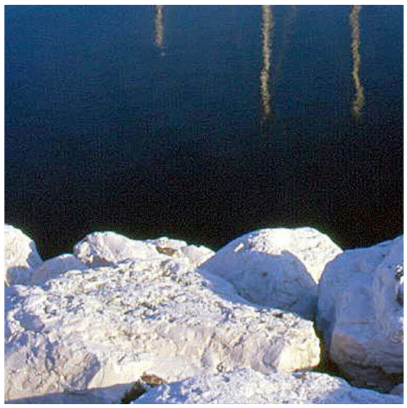
Appropriate Assessment

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Appropriate Assessment of SFPC Maintenance Dredging Application

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1 INTRODUCTION

1.1 APPROPRIATE ASSESSMENT OF NATURA 2000 SITES

Article 6(3) of Council Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora, better known as "The Habitats Directive", states that any plan or project likely to have significant effects on a Natura 2000 site must undergo the process of appropriate assessment. Proposed plans or projects can only be approved if it has been ascertained that they will not adversely affect the integrity of the Natura 2000 site(s) concerned or, in the case of a negative assessment where there are no alternative solutions, the scheme can only be approved for reasons of overriding public interest.

This report details the appropriate assessment which has been carried out to accompany the Shannon Foynes Port Company (SFPC) application for a Dump at Sea Permit. The Dump at Sea application covers the maintenance dredging operations which will be carried out over the coming years at both Ted Russell Dock in Limerick City and Foynes Harbour. The dredged spoil from both facilities will be dumped at one of the three approved dump sites in the Shannon Estuary which will be utilised by SFPC until the maximum tonnage is reached as opposed to the previously issued 5 year permit as per discussions with the EPA.

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1.2 PROJECT SETTING AND BACKGROUND

Shannon Foynes Port Company controls approximately 200 square miles of waterway in the Shannon Estuary however there are just two locations in their ownership which require on-going maintenance dredging;

- The approach channel and enclosed Dock at Ted Russell Dock, Limerick
- The Berths and Channel at the Foynes Terminal

1.2.1 History of Maintenance Dredging

Ted Russell Dock in Limerick City

Mud and Silt is carried down river and is initially deposited where the river widens at the approach channel to the Dock Gates (these Gates retain the fixed head of water within the enclosed Dock when the tide recedes). The quantity of mud deposited annually in the channel is approximately 30,000 tonnes during a wet summer as the large volume of fresh water coming down river scours away the silt from the channel. However during a dry summer the volume of fresh water flowing down river is restricted because the rainfall is low in the catchment area and also the E.S.B. retains enough water

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up river to service the Hydro-Electric Station at Ardnacrusha. During a dry summer quantities to be dredged can exceed 120,000 tonnes. The latter scenario requires continuous dredging from June until November annually.

A fraction of the mud deposited in the channel is carried into the enclosed Dock as the Gates are opened for a period at each high tide. This necessitates maintenance dredging and quantities of up to 6,000 tonnes annually are involved.

Foynes Harbour

During the West Jetty development in 1999/2000 capital dredging was carried out at all berths, approach channel and inner harbour. In order to maintain the depths achieved, maintenance dredging is required annually. The maximum is 150,000 tonnes annually.

1.2.2 Disposal of Dredge Spoil

In accordance with Section 5(2) of the Dumping at Sea Acts, 1996 to 2009, the dumping of substances or material at sea in only acceptable when the Agency is satisfied that no other suitable alternative means of disposal is possible. As it was not found practicable to bring the material ashore for alternative use (Please see Section B.1 of the Dumping at Sea Application for further details) this assessment is based on the use of the approved dump sites for disposal of dredge spoil. Ted Russell Dock utilizes two dump sites nearest Limerick City where as Foynes Harbour uses a third dump site located farther out in the estuary past Foynes Island. See Section 3.1.1 for further details.

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2 REQUIREMENTS OF A HABITATS DIRECTIVE ASSESSMENT

2.1 INTRODUCTION

The Habitats Directive provides legal protection for habitats and species of European importance. The main aim of the Habitats Directive is "*to contribute towards ensuring biodiversity through the conservation of natural habitats of wild fauna and flora in the European territory of the Member States to which the treaty applies"* (92/43/EEC). Actions taken in order to fulfil the Directive must be designed to "*maintain or restore, at a favourable conservation status, natural habitats and species of wild fauna and flora of Community interest*" (92/43/EEC).

The Directive provides for the creation of protected sites, SACs, for a number of habitat types and certain species of flora and fauna. The Directive also seeks to establish Natura 2000, a network of protected areas throughout Europe. SACs, together with SPAs designated under the Birds Directive (79/409/EEC), form the Natura 2000 network. The Directive was incorporated into Irish law by the European Communities (Natural Habitats) Regulations (S.I. No. 94 of 1997) under Regulation 31 (Annex 1.2).

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An assessment is required under the Habitats Directive for any plan or project likely to have significant effect on a Natura 2000 site. Article 6, paragraphs 3 and 4 of the Habitats Directive state as follows:

> *6(3) Any plan or project not directly connected with or necessary to the management of the site but likely to have a significant effect thereon, either individually or in combination with other plans or projects, shall be subject to appropriate assessment of its implications for the site in view of the site's conservation objectives. In the light of the conclusions of the assessment of the implications for the site and subject to the provisions of paragraph 4, the competent national authorities shall agree to the plan or project only after having ascertained that it will not adversely affect the integrity of the site concerned and, if appropriate, after having obtained the opinion of the general public.*
>
> *6(4) If, in spite of a negative assessment of the implications for the site and in the absence of alternative solutions, a plan or project must nevertheless be carried out for imperative reasons of overriding public interest, including those of a social or economic nature, the Member State shall take all compensatory measures necessary to ensure that the overall coherence of Natura 2000 is protected. It shall inform the Commission of the compensatory measures adopted.*
>
> *Where the site concerned hosts a priority natural habitat type and/or a priority species, the only considerations which may be raised are those relating to human health or public safety,*

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to beneficial consequences of primary importance for the environment or, further to an opinion from the Commission, to other imperative reasons of overriding public interest.

This means that, where the implementation of the proposed development is likely to have a significant effect on a Natura 2000 site, the Competent Authority must ensure that an appropriate assessment is carried out in view of that site's conservation objectives. The proposed development can only be approved if it has been ascertained that it will not adversely affect the integrity of the Natura 2000 sites concerned or, in the case of a negative assessment and where there are no alternative solutions, the scheme can only be approved for reasons of overriding public interest.

2.2 GUIDANCE

This appropriate assessment of the maintenance dredging application to include both Foynes Port and Limerick Dock has been carried out using the following guidance:

- Department of Environment Heritage and Local Government Circular NPW 1/10 and PSSP 2/10 on *Appropriate Assessment under Article 6 of the Habitats Directive – Guidance for Planning Authorities* March 2010.
- Appropriate Assessment of Plans and Projects in Ireland: Guidance for Planning Authorities, Department of the Environment, Heritage and Local Government 2009; http://www.npws.ie/en/media/NPWS/Publications/CodesofPractice/AA%20Guidance.pdf
- Managing Natura 2000 Sites: the provisions of Article 6 of the Habitats Directive 92/43/EEC, European Commission 2000; http://ec.europa.eu/environment/nature/natura2000/management/docs/art6/provision_of_art6_en.pdf
- Assessment of Plans and Projects Significantly Affecting Natura 2000 Sites: Methodological guidance on the provisions of Article 6(3) and (4) of the Habitats Directive 92/43/EEC; http://ec.europa.eu/environment/nature/natura2000/management/docs/art6/natura_2000_assess_en.pdf
- Guidance document on Article 6(4) of the 'Habitats Directive' 92/43/EEC – Clarification of the concepts of: alternative solutions, imperative reasons of overriding public interest, compensatory measures, overall coherence, opinion of the commission. http://ec.europa.eu/environment/nature/natura2000/management/docs/art6/guidance_art6_4_en.pdf
- Guidance document on the implementation of the birds and habitats directive in estuaries and coastal zones with particular attention to port development and dredging. http://ec.europa.eu/environment/nature/natura2000/management/docs/guidance_doc.pdf

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Based on these guidelines, the assessment process is a four-staged approach as described below. An important aspect of the process is that the outcome at each successive stage determines whether a further stage in the process is required.

Stage 1 *Screening for Appropriate Assessment*

Screening is the process that addresses and records the reasoning and conclusions in relation to the first two tests of Article 6(3) of the Habitats Directive:

i) whether a plan or project is directly connected to or necessary for the management of the site, and

ii) whether a plan or project, alone or in combination with other plans and projects, is likely to have significant effects on a Natura 2000 site.

If the effects are deemed to be significant, potentially significant, or uncertain, or if the screening process becomes overly complicated, then the process must proceed to Stage 2.

Stage 2 *Appropriate Assessment*

This stage considers whether the plan or project, alone or in combination with other projects or plans, will have adverse effects on the integrity of a Natura 2000 site, and includes any mitigation measures necessary to avoid, reduce or offset negative effects. If the assessment is negative, i.e. adverse effects on the integrity of a site cannot be excluded, then the process must proceed to Stage 4, or the plan or project should be abandoned.

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Stage 3 *Alternative Solutions*

This stage examines any alternative solutions or options that could enable the plan or project to proceed without adverse effects on the integrity of a Natura 2000 site. The process must return to Stage 2 as alternatives will require appropriate assessment in order to proceed. Demonstrating that all reasonable alternatives have been considered and assessed, and that the least damaging option has been selected, it is necessary to progress to Stage 4.

Stage 4 *Imperative Reasons of Overriding Public Interest (IROPI)/Derogation*

Stage 4 is the main derogation process of Article 6(4) which examines whether there are imperative reasons of overriding public interest (IROPI) for allowing a plan or project that will have adverse effects on the integrity of a Natura 2000 site to proceed in cases where it has been established that no less damaging alternative solution exists. Compensatory measures must be proposed and assessed. The Commission must be informed of the compensatory measures. Compensatory measures must be practical, implementable, likely to succeed, proportionate and enforceable, and they must be approved by the Minister.

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2.3 OTHER LEGISLATION

Natural Heritage Areas (NHA) are sites of national significance, proposed Natural Heritage Areas (pNHA) are sites that have been proposed but not formally designated. When formally designated, a pNHA is legally protected from damage under Irish legislation in the form of the Wildlife (Amendment) Act 2000. However, as this Appropriate Assessment report deals only the Natura 2000 sites NHAs and pNHAs are not considered further in this study, other than in the description of the study area.

The EU Birds Directive (Council Directive 79/409/EEC on the Conservation of Wild Birds) is the main mechanism for protecting, management and control of bird species and defines rules for their exploitation. According to Article 4 of the Birds Directive *"species mentioned in Annex I shall be the subject of special conservation measures concerning their habitat in order to ensure their survival and reproduction in their area of distribution".* The key element of the Birds Directive is that it provides for the creation of the Special Protection Areas (SPAs) for the protection of Annex I species as well as for regularly occurring migratory species not listed in Annex I. The Birds Directive is implemented in Ireland under the Wildlife Act (1976) and the Wildlife (Amendment) Act (2000).

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3 STAGE 1 - SCREENING

The screening stage involves the following:

- Description of plan or project, and local site or plan area characteristics.
- Identification of relevant Natura 2000 sites and compilation of information on their qualifying interests.
- Assessment of likely effects – direct, indirect and cumulative.
- Screening conclusions.

3.1 SITE LOCATION AND DESCRIPTION OF PROPOSED WORKS

3.1.1 Site Location

3.1.1.1 Dredging

Foynes Port is situated on the southern shores of the Shannon Estuary west of Limerick City (Figure 3.1). Foynes Port is a major deepwater facility capable of accommodating ships up to 198m in length, and a draft up to 10.5m. Foynes caters for most cargo types including liquid bulk, dry bulk, break bulk, liquid and project cargoes. Foynes is the principle general purpose terminal on the Estuary.

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Limerick Docks also lies on the southern shores of the River Shannon about 11 kilometers inland from the Shannon Estuary (Figure 3.1). Limerick Docks contain quays totalling 914 meters with alongside depth of at least 5m in an enclosed basin. The berths can accommodate vessels up to 152 meters long. It is a general purpose terminal in Limerick city catering for dry bulk, break bulk, liquid and special cargoes.

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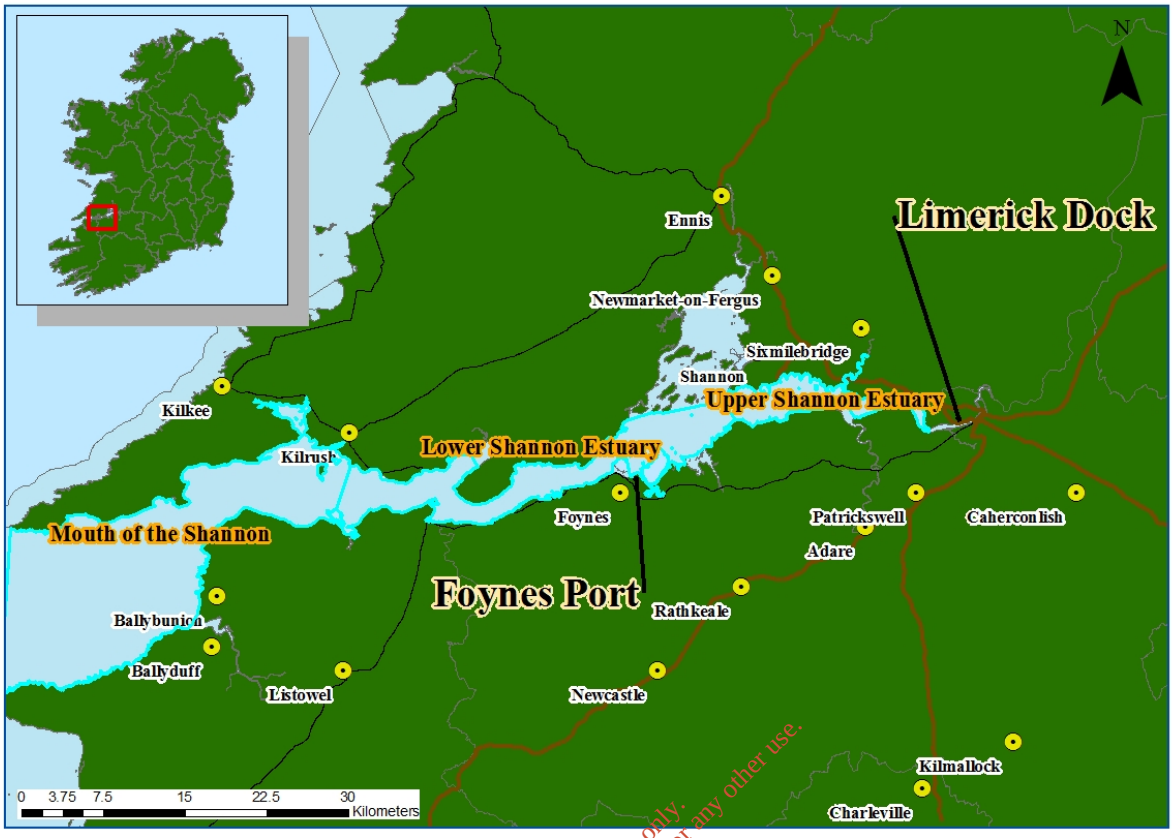


Figure 3-1 Regional Context of Foynes Port and Limerick Dock

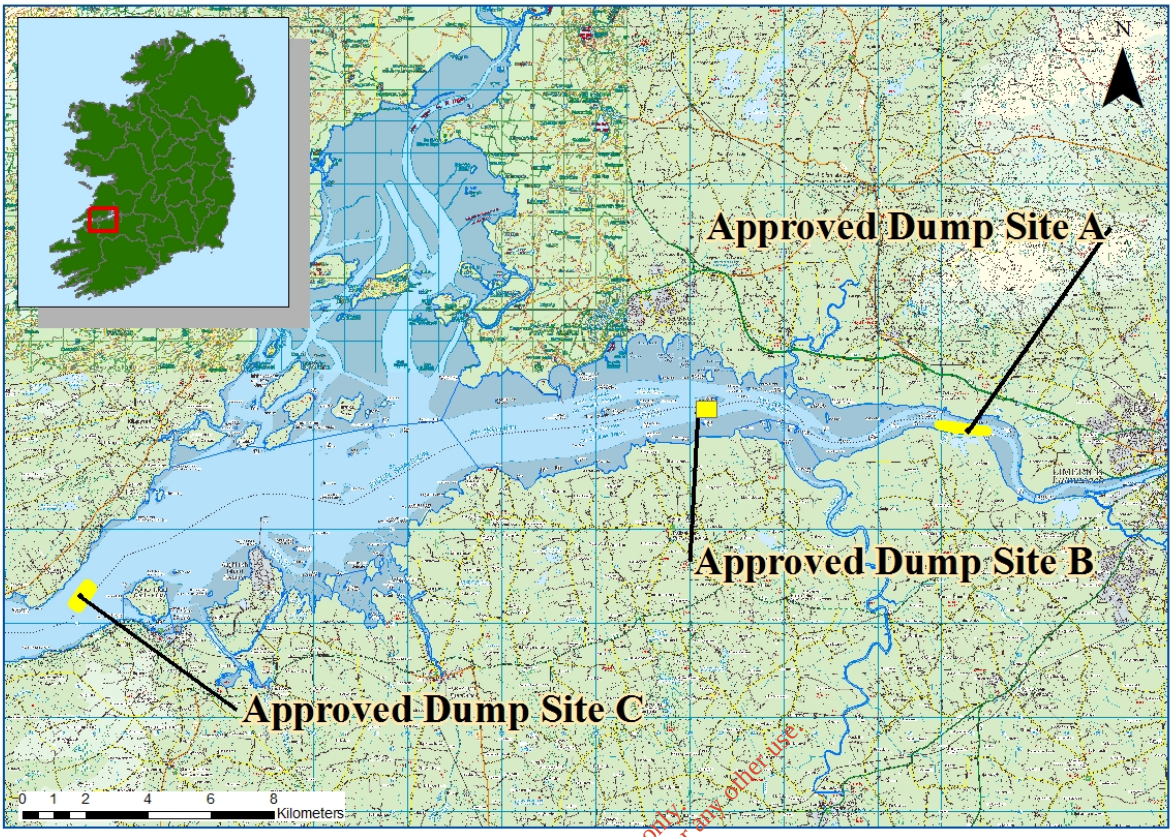
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3.1.1.2 Dumping

Dump Sites

There are two approved dump sites for silt and mud dredged from Ted Russell Dock in Limerick which have been used since 1999. Approved dump site A lies just west of Cratloe Creek to the southern shore of the estuary and approved dump site B lies just west of the River Maigue and Mellon Point and is directly in front of Sod Island in the centre of the river channel. The third dump site in dump site C which is located west of Foynes Island nearest the northern shore of the Shannon Estuary. All three sites are shown in Figures 3.3 and 3.4.

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Figure 3-2 Regional Context of SFPC Dump Site Locations

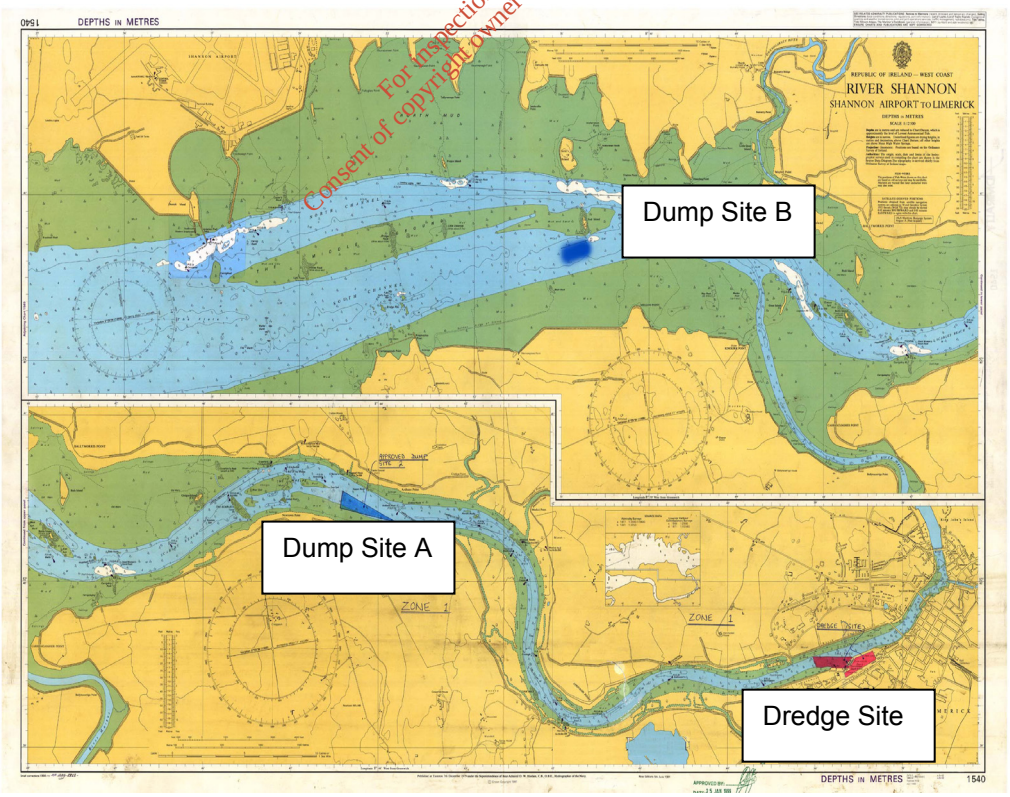


Figure 3-3 Location of Approved Dump Sites A & B for Limerick together with Dredge Site

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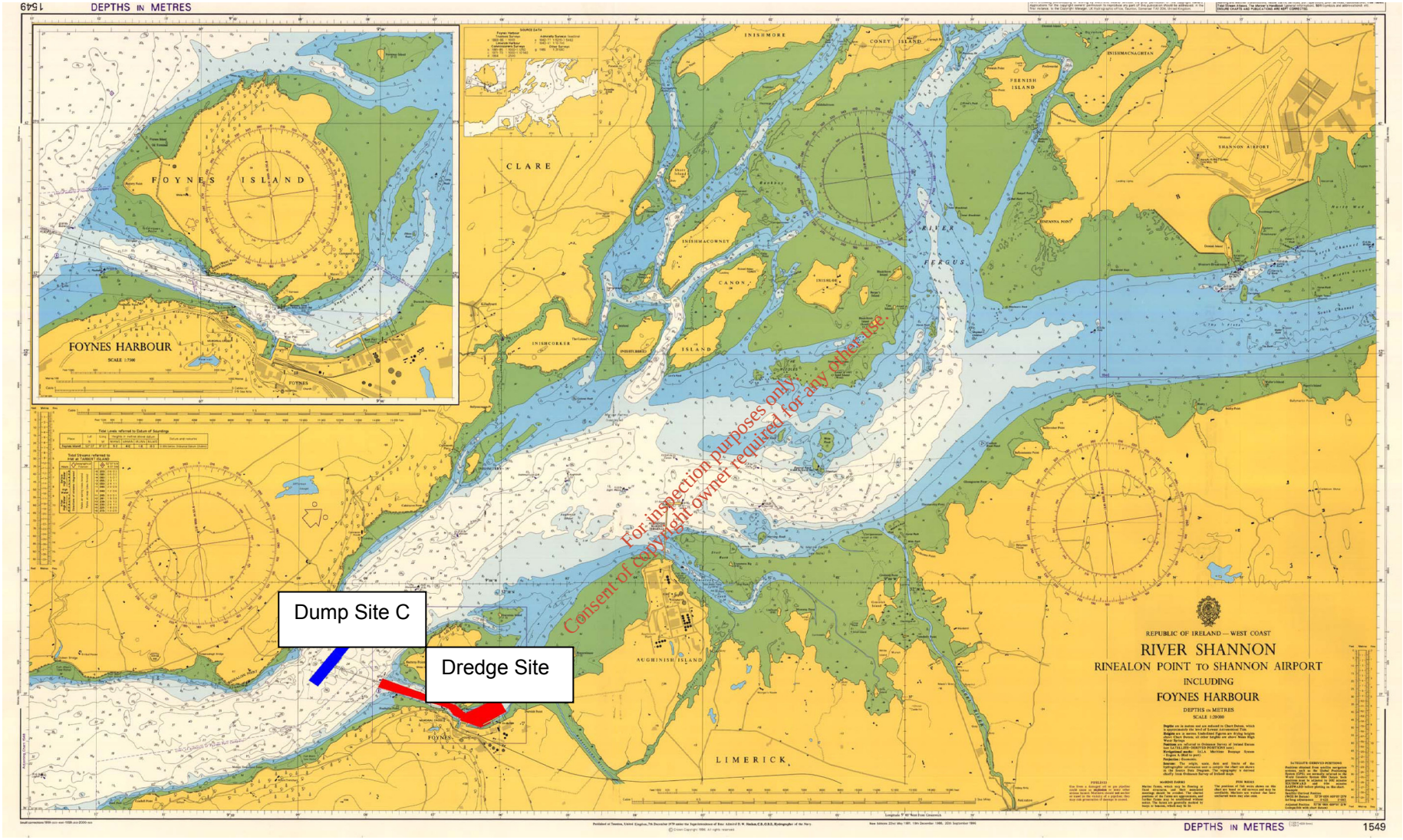


Figure 3-4 Location of Approved Dump Sites C for Foynes together with Dredge Site

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3.1.2 Proposed Maintenance Dredging Programme

This appropriate assessment relates to the proposed dredging and subsequent dumping at sea, which will take place as part of the application for a maintenance dumping at sea permit application for SFPC to cover both Limerick Dock and Foynes Port. A full description of the proposed maintenance dredging programme and associated dumping at sea is contained in Sections A, B & E of the dumping at sea application. A synopsis of the work programme is provided below.

3.1.2.1 Sedimentation and accretion – the need for dredging

Ted Russell Dock

The upper Shannon catchment area is subjected to varying degrees of runoff and soil erosion, which contributes to silt accretion throughout the estuary. In the estuarine area of the river vast quantities of sediment are eroded, held in suspension by the velocity of the tide and then deposited during slack water periods at high and low tide times.

The pattern of silt accretion at Ted Russell Dock is further compounded during a dry Summer and Autumn as the amount of fresh water released from the upper Shannon into the estuary is vastly reduced to maintain the head of water required to power the Hydroelectric Station at Ardnacrusha. This reduces the volume of water required to scour the silt from the vicinity of Ted Russell Dock. This can lead to vast deposits of silt at the approach channel to the Docks (up to 3 metres above the required datum) where the river widens. This explains the necessity to seek permits for 120,000 tonnes annually which includes a contingency amount to cover exceptionally dry periods. This figure would be the absolute maximum quantity dredged in any year.

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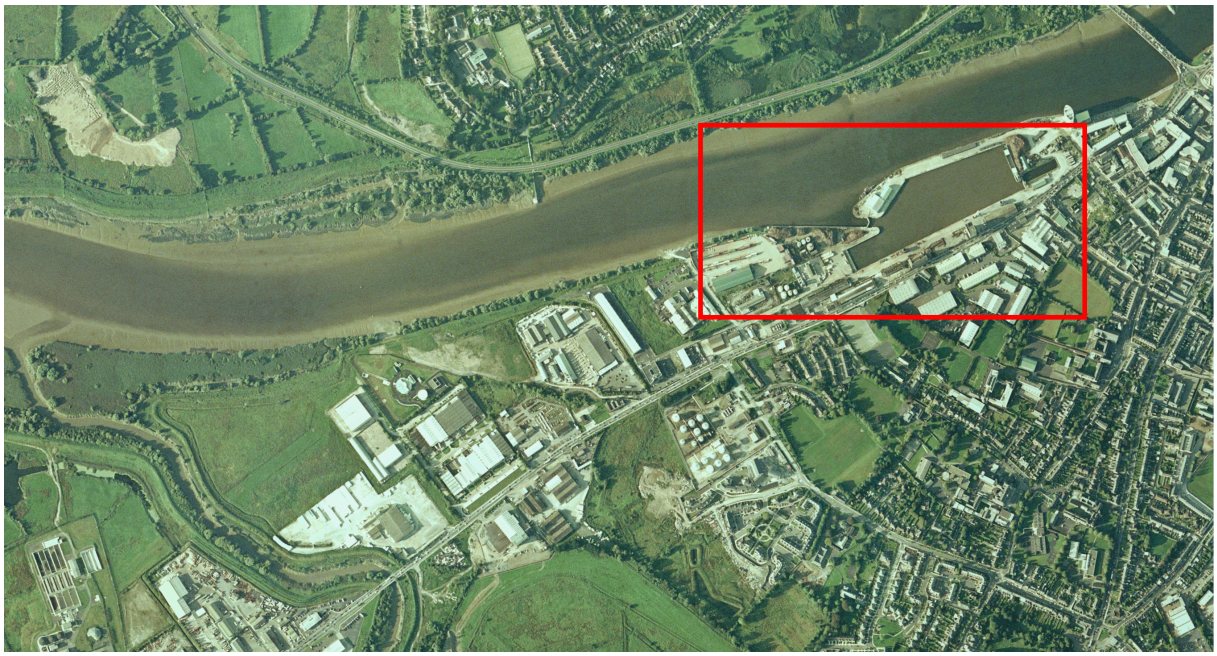


Figure 3-5 Aerial overview of Limerick Dock

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Foynes Harbour

As is the case with Limerick Dock huge quantities of silt are eroded from the river banks and riverbed, held in suspension during tidal flows and deposited at the end of the tide in Foynes Harbour. However this is further added to during ebb tides by the eroded silt from the tributaries feeding into the Estuary East of Foynes i.e. the Maigue, the Deel and the Fergus, in particular during a wet Summer and Autumn when the volume of runoff water is suddenly increased. Since the Capital Dredging works carried out in 1999/2000, the regime of the harbour has changed due to the deepening of the Berths and inner harbour area and also by the lengthening of the West Quay. This has led to a significant increase in the volume of silt building up on the river bed. H R Wallingford have reported that this is common following major capital dredging works and tends to settle down over time as the new regime takes effect. The rate of siltation is likely to reduce in the longer term. They have also indicted that it is likely that a new regime would be established within 5 to 7 years after the capital dredging. This explains the necessity to seek permits for 150,000 tonnes annually which include a contingency amount to cover exceptional periods. This figure would be the absolute maximum quantity dredged in any year.

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Figure 3-6 Aerial overview of Foynes Harbour

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Anticipated Timescale for Dredging

It is anticipated that dredging would be required in Limerick between July or August and in Foynes Port between October and November. This is the typical timescale for dredging but can vary based on climatic conditions such as periods of heavy rainfall or excessive dry periods when the accumulation rates increase.

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3.2 IDENTIFICATION OF RELEVANT NATURA 2000 SITES AND COMPILATION OF INFORMATION ON THEIR QUALIFYING INTERESTS.

The Habitats Directive contains a list of habitats (Annex I) and species (Annex II) for which SACs must be established by Member States. Similarly, the Birds Directive contains lists of important bird species (Annex I) and other migratory bird species for which SPAs must be established. Those that are known to occur at a site are referred to as 'qualifying interests' and are listed in the Natura 2000 forms which are lodged with the EU Commission by each Member State. A 'qualifying interest' is one of the factors (such as the species or habitat that is present) for which the site merits designation.

Thirteen Natura 2000 sites are located within a precautionary distance of 15 kilometres of the proposed dredge and dump sites in both Limerick Dock and Foynes Port. The full list of these sites is shown in Table 3.1 together with Figure 3.7. Two pNHA sites are also located within the study area;

- Site Code 000435 Inner Shannon Estuary - South Shore
- Site Code 002048 Fergus Estuary and Inner Shannon – North Shore

However, as outlined in section 2.3 this Appropriate Assessment report deals only with Natura 2000 sites.

The Department of the Environment, Heritage and Local Government guidance on appropriate assessment states that a distance of 15km is currently recommended in the case of plans. For projects, the distance could be reduced however, given the sensitivity of the ecological receptors within the study area a precautionary approach of 15km has also been adopted for this project.

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Code	Site
SPA Code 004077	River Shannon and River Fergus SPA
SPA Code 004161	Stack's to Mullaghareirks, West Limerick Hills and Mount Eagle SPA
SAC Code 002165	Lower River Shannon SAC
SAC Code 000064	Poulnagordon Cave (Quin)
SAC Code 000030	Danes Hole, Poulnalecka
SAC Code 002319	Kilkishen House
SAC Code 002316	Ratty River Cave
SAC Code 000051	Lough Gash Turlough
SAC Code 001013	Glenomra Wood
SAC Code 002279	Askeaton Fen Complex
SAC Code 000174	Curraghchase Woods
SAC Code 000432	Barrigone
SAC Code 000439	Tory Hill

Table 3-1 SAC and SPA sites located within 15km Buffer zone

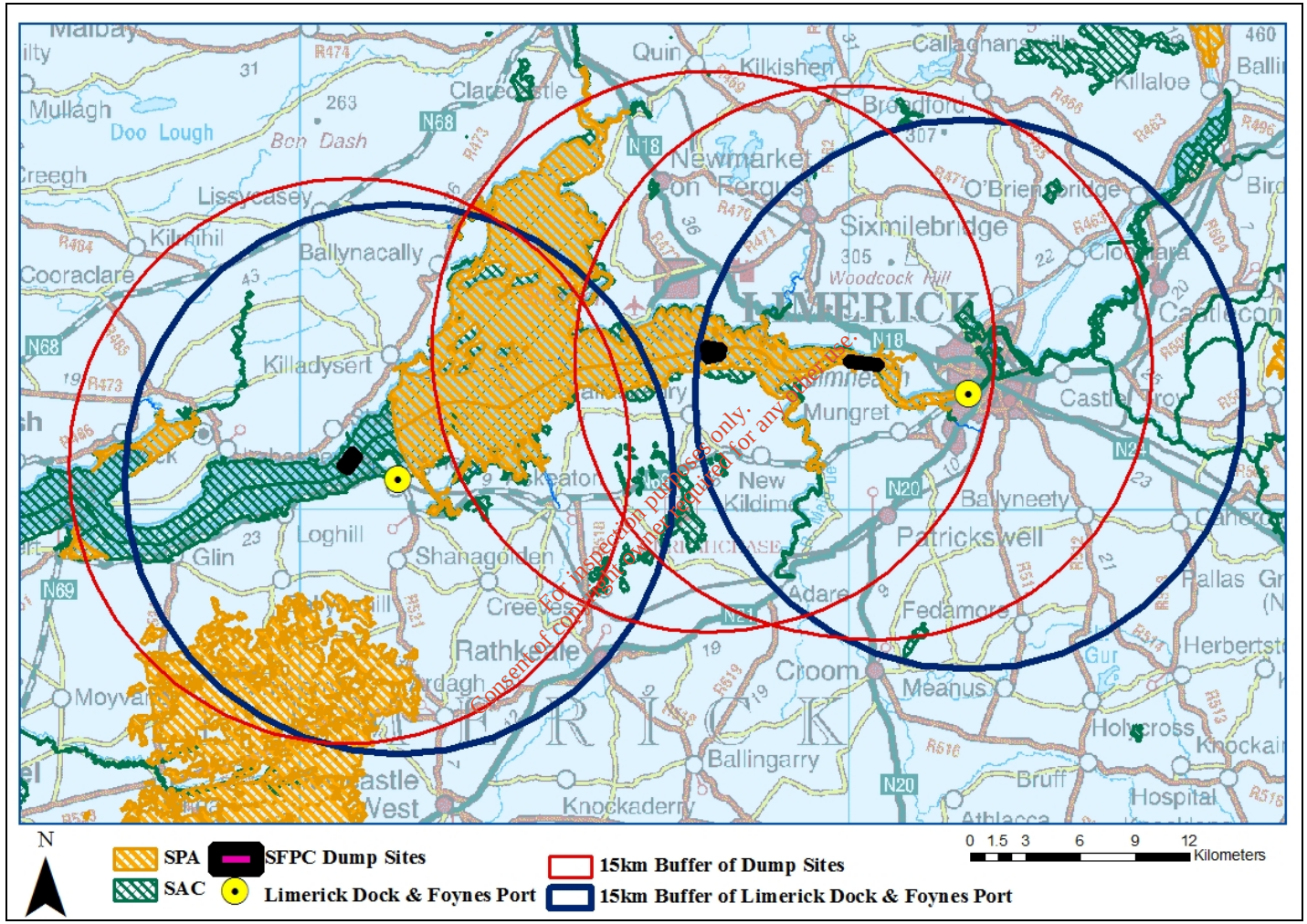
The proposed works are located directly within the River Shannon and River Fergus SPA and the Lower River Shannon SAC and therefore form the key areas of concern for this appropriate assessment. However, the remaining SPA and ten SACs have either no direct hydrological connection to the area of the proposed dredging or dump sites or due to the distance, no direct linkage between the project lands and Natura 2000 site habitats and species for which it is designated and it is therefore appropriate to screen them out of this assessment.

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Code	Site
SPA Code 004161	Stack's to Mullaghareirks, West Limerick Hills and Mount Eagle SPA
SAC Code 000064	Poulnagordon Cave (Quin)
SAC Code 000030	Danes Hole, Poulnalecka
SAC Code 002319	Kilkishen House
SAC Code 002316	Ratty River Cave
SAC Code 000051	Lough Gash Turlough
SAC Code 001013	Glenomra Wood
SAC Code 002279	Askeaton Fen Complex
SAC Code 000174	Curraghchase Woods
SAC Code 000432	Barrigone
SAC Code 000439	Tory Hill

Table 3-2 SPA and SACs screened out of the assessment

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Figure 3-7 Natura 2000 sites in the vicinity of the proposed works within 15km buffer zone

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Details in relation to the qualifying features of the Lower River Shannon SAC and River Shannon and Fergus SPA are described in Table 3.3 & 3.4. The information contained in this table is based on the findings in Ireland's Article 17 Report to the European Commision '*The Status of EU Protected Habitats and Species in Ireland*' (NPWS, 2008). The background documents associated with this report provides the first assessment of the status of the habitats and species that Ireland is required to protected under the Habitats Directive. The conservation status for listed habitats and species is assessed across the whole national territory, and therefore, site by site assessments are not available at this time due to gaps in monitoring data. There is no similar information collated for SPAs in terms of National Conservation Status. Equally no Conservation Management Plan exists for the two main Natura 2000 sites which are applicable in this investigation.

In the absence of site specific management plans the *Draft (Generic) Conservation Objectives for the Lower River Shannon SAC* and the *Proposed Special Conservation Interests for the River Shannon and River Fergus Estuaries SPA* were used. Coupled with this the NPWS Natura 2000 site synopsis forms were also utilised all of which can be found in **Appendix A**. The features of interest and Conservation Objectives of the Natura 2000 sites, along with an analysis of the potential effects the proposed development may have on these sites, are described in Tables 3.3 & 3.4.

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It should be noted that the Shannon Estuary SPA is to be re-designated and an extension of the original area is under consideration - it is possible that this SPA could be extended up to an area of 32,000 ha of which the vast majority lies within the SAC boundary.

The Draft (Generic) Conservation objectives for the Lower River Shannon SAC include:

Objective 1:

To maintain the Annex I habitats for which the cSAC has been selected at favourable conservation status: Large shallow inlets and bays; Estuaries; *Salicornia* and other annuals colonising mud and sand; Vegetated sea cliffs of the Atlantic and Baltic coasts; Mediterranean salt meadows (*Juncetalia maritimi*); Coastal lagoons; Mudflats and sandflats not covered by seawater at low tide; Atlantic salt meadows (*Glauco- Puccinellietalia maritimae*); Sandbanks which are slightly covered by sea water all the time; Reefs; Perennial vegetation of stony banks; Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-*Batrachion vegetation; *Molinia* meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion*

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caeruleae); Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*)

Objective 2:

To maintain the Annex II species for which the cSAC has been selected at favourable conservation status: Lampetra fluviatilis, Lampetra planeri, Petromyzon marinus, Salmo salar, Margaritifera margaritifera, Tursiops truncatus, Lutra lutra

Objective 3:

To maintain the extent, species richness and biodiversity of the entire site

Objective 4:

To establish effective liaison and co-operation with landowners, legal users and relevant authorities.

Objective 5:

To maintain the favourable conservation condition of Lagoons in Lower River Shannon cSAC (site code 002165),

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Natura 2000 Site	Location	Qualifying Interests	Site Sensitivity	Conservation Status*	Threats*
Site Code 2165 - Lower River Shannon	Both Limerick Dock and Foynes Port are located directly within the SAC boundary	Estuaries	Surface and marine water dependent. Moderately sensitive to hydrological change. Moderate sensitivity to pollution. Sensitive to changes in salinity and tidal regime as well as coastal development	Poor	The main threats to this habitat relate to impacts arising from aquaculture, fishing, coastal development and water pollution
		Mudflats and sandflats not covered by seawater at low tide.	Surface and marine water dependent. Moderately sensitive to hydrological change. Moderate sensitivity to pollution. Sensitive to changes in salinity and tidal regime as well as coastal development	Poor	The main serious threats to this habitat arise from aquaculture, fishing, bait dredging, and removal of fauna. Reclamation of land, coastal protection works and invasive species, particularly cord-grass. In addition, there is some concern over the potential impact that hard coastal defence structures may have, in combination with sea-level rise, for the long term extent of this habitat.

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* http://www.npws.ie/en/PublicationsLiterature/ConservationStatusReport/

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		Coastal Lagoons	Surface, ground and marine water dependent. Highly sensitive to hydrological change. Highly sensitivity to pollution. Sensitive to changes in salinity and tidal regime.	Bad	The most damaging activity is the deliberate drainage of the largest lagoons for agricultural reasons and smaller lagoons for safety reasons. Further loss of habitat has occurred as a result of natural silting-up. The quality of the habitat has been impacted by water pollution in the form of excessive nutrient enrichment mostly from agricultural sources, but also due to effluents arising from increased urbanisation and industrial activities.
		Vegetated sea cliffs of the Atlantic and Baltic Coasts	Coastal development. Erosion, over grazing and recreation	Poor	Threats to this habitat include erosion, grazing; recreational pressures; development of golf courses and housing; dumping and cutting of peat. In some cases coastal protection works interfere with the natural functioning of sea cliffs, particularly those of the soft variety, which are prone to erosion. The impacts of climate change are likely to result in more cliffs being artificially consolidated or stabilised.

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	Salicornia and other annuals colonizing mud and sand	Marine water dependent. Medium sensitivity to hydrological change. Moderate sensitivity to pollution. Sensitive to changes in salinity and tidal regime as well as infilling, reclamation, invasive species	Poor	Main threats and impacts: Invasive species, Erosion and accretion.
	Atlantic salt meadows (*Glauco-Puccinellietalia maritime*)	Marine and groundwater dependent. Medium sensitivity to hydrological change. Sensitive to changes in salinity and tidal regime as well as overgrazing, erosion and accretion		The main impacts to this habitat are overgrazing by sheep and cattle and erosion. The presence of alien species, particularly common cordgrass (*Spartina anglica*) is also prevalent threat to this habitat throughout Ireland. There has been minor losses of this habitat due to infilling and reclamation.
	Mediterranean salt meadows (*Juncetalia maritimi*)	Marine and groundwater dependent. Medium sensitivity to hydrological change. Sensitive to changes in salinity and tidal regime as well as coastal development and reclamation	Poor	The most common impact to this habitat is over-grazing by cattle or sheep. Ther has been some minor losses of habitat to infilling and reclamation.
	Watercourses of plain to montance levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation	Surface and groundwater dependent. Highly sensitive to hydrological changes. Highly sensitive to pollution.	Bad	The main threats include: eutrophication, overgrazing, excessive fertilisation, afforestation, and the introduction of invasive alien species.

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		Sandbanks which are slightly covered by sea water all the time	Marine water dependent. Medium sensitivity to hydrological change. Sensitive to changes in salinity and tidal regime as well as infilling, reclamation and invasive species	Poor	The potential for aggregate extraction, coal extraction and wind farm development remain a threat to the integrity of sandbanks.
		Large shallow inlets and bays	Surface and marine water dependent. Low sensitivity to hydrological changes. Aquaculture, fishing and pollution	Poor	Impacts arising from aquaculture, fishing, dumping of wastes and water pollution are considered to be the principal threats to this habitat.
		Reefs	Sensitive to disturbance, pollution	Poor	Main threats include: professional fishing; taking for fauna; taking for flora; water pollution; climate change and change in species composition
		Perennial vegetation of stony banks	Marine water dependent. Low sensitivity to hydrological changes. Sensitive to coastal development, recreation and gravel removal.	Poor	The main threat to this habitat is the disruption of the sediment supply, owing to the interruption of the coastal processes, caused by developments such as car parks and coastal defence structures including rock armour and sea walls. The removal of gravel is still one of the most widespread and damaging activities directly affecting this habitat. Shingle vegetation is fragile and damage caused by trampling, horse riding and vehicles can be significant.

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		Spartina swards (*Spartinion maritimae*)	Marine water dependent. Medium sensitivity to hydrological changes. As Spartina is considered to be an invasive species in Ireland, it is assessed in a different way to other habitats. Increases in the area and extent of Spartina swards are actually considered to be unfavourable and as future expansion is considered likely, the overall conservation status of this habitat is rated as poor.	Poor	As Spartina is considered to be an invasive species in Ireland, it is assessed in a different way to other habitats. Increases in the area and extent of Spartina swards are actually considered to be unfavourable and as future expansion is considered likely, the overall conservation status of this habitat is rated as poor.
		Molinia meadows on calcareous, peaty or clay-silt-laden soils (*Molinion caerulecae*)	Surface and groundwater dependent. Moderately sensitive to hydrological change. Sensitive to changes in management and nutrient status.	Bad	Agricultural intensification over the past century, drainage and more recently, abandonment of pastoral systems, which contributes to rank vegetation and scrub encroachment, all lead to the loss of some typical flora and to a reduction in the area of this habitat.
		Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* also *Salix spp*. And sometimes *Quercus robur*	Surface and groundwater dependent. Highly sensitive to hydrological changes. Sensitive to changes in management.	Bad	The area of this habitat has declined throughout Ireland. The main threats include sub-optimal grazing regimes, drainage, alien invasive species together with the fragmentation of its habitat for agriculture and/or felling for timber.

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		River Lamprey	Surface water dependent. Highly sensitive to hydrological change	Good	The main threats to this species include channel maintenance works, barriers to migration such as weirs, gross pollution and specific pollutants.
		Brook Lamprey	Surface water dependent. Highly sensitive to hydrological change	Good	The main threats to this species include channel maintenance works, barriers to migration such as weirs, gross pollution and specific pollutants.
		Sea Lamprey	Surface water dependent. Highly sensitive to hydrological change	Good	The main threats to this species include channel maintenance works, barriers to migration such as weirs, gross pollution and specific pollutants.
		Atlantic Salmon	Surface water dependent. Highly sensitive to hydrological change	Bad	Numerous threats impact upon this species the most important of which are reduced marine survival (probably as a result of climate change), poor river water quality (resulting from factors such as inadequate sewage treatment, agricultural enrichment, acidification, erosion and siltation), forestry-related pressures and over-fishing.

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		Bottle-nosed Dolphin	Surface water dependent. Highly sensitive to hydrological change	Good	The main threats to this species include by-catch in fishing gear, pollution of the marine environment and habitat degradation and increased disturbance from dolphin watching boats
		Freshwater Pearl Mussel	Surface water dependent. Highly sensitive to hydrological change. Very highly sensitive to pollution.	Bad	The principal threat to this species is poor substrate quality due to increased growth of algal and macrophyte vegetation as a result of severe nutrient enrichment coupled with increased levels of siltation.

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	Otter	Surface and marine water dependent. Moderately sensitive to hydrological change. Sensitive to pollution	Poor	A diverse range of threats and impacts currently affect otters in Ireland. Use of pesticides, fertilization, removal of hedges and copses, removal of scrub, felling of native or mixed woodland, professional fishing (including lobster pots and fyke nets), hunting, trapping, poisoning, poaching, sand and gravel extraction, mechanical removal of peat, urbanised areas, human habitation, continuous urbanization, industrial or commercial areas, discharges, disposal of household waste, disposal of industrial waste, disposal of inert materials, other discharges, routes, autoroutes, bridge, viaduct, water pollution, other forms or mixed forms of pollution, infilling of ditches, dykes, ponds, pools, marshes or pits, drainage, management of aquatic and bank vegetation for drainage purposes, removal of sediments, canalization or modifying structures of inland water course

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Table 3-3 Description of Natura 2000 sites (SAC) occurring within the 15km Buffer Zone

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Site Code - 4077 River Shannon and River Fergus Estuaries	Limerick Dock is located within the current SPA Boundary while Foynes Port is outside the current SPA boundary. Limerick Dock dump sites are also located within the SPA boundary where as Foynes Port dump site is outside the current SPA boundary.	The site supports species/populations at levels of international importance of: Comorant; Light-Bellied Brent Goose; Shelduck; Wigeon; Teal; Ringed Plover; Gloden Plover; Lapwing; Knot; Dunlin; Black-tailed Godwit; Bar-tailed Godwit; Curlew; Redshank; Greenshank; 20,000 wintering waterbirds, whooper swan, pintail, shoveler, scaup, black-headed gull, wetland & waterbirds.	Loss of Habitat or fragmentation. Highly sensitive to hydrological change. Increased disturbance.	As no catchment management plan exists for this site nor does Ireland's Article 17 Report to the European Commision '*The Status of EU Protected Habitats and Species in Ireland'* (NPWS, 2008) cover SPAs we do not have a definitive list of threats. The generic measures provide an indication of the main threats which is; **To maintain the bird species of special conservation interest, for which this SPA has been listed, at favourable conservation status.** Favourable conservation status of a habitat is achieved when · its natural range, and area it covers within that range, is stable or increasing, and · the ecological factors that are necessary for its long-term maintenance exist and are likely to continue to exist for the foreseeable future, and · the conservation status of its typical species is favourable as defined below. The favourable conservation status of a species is achieved when:· population data on the species concerned indicate that it is maintaining itself, and · the natural range of the species is neither being reduced or likely to be reduced for the foreseeable future, and there is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis.	No information currently available on the threats to the qualifying features of this site.

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Table 3-4 Description of Natura 2000 sites (SPA) occurring within the 15km Buffer Zone

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3.2.1 Screening Apprasial

The features of interest and Conservation Objectives of the Natura 2000 sites, along with an analysis of the potential effects the proposed development may have on these sites, are described in *Table 3.4* to *Table 3.5*. The information required and assessment criteria of screening specified in the European guidance on Appropriate Assessment (European Commission Environment Division's *Assessment of plans and projects significantly affecting Natura 2000 sites*, 2001) have served as the basis for the following screening appraisal. Measures which will be implemented to reduce or mitigate impacts of the proposed development on the Natura 2000 sites are provided where applicable in the tables below.

The proposal is not directly connected with, or necessary to, the conservation management of the River Shannon and River Fergus Estuaries SPA and the Lower River Shannon SAC.

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Table 3-5 SCREENING MATRIX - River Shannon and River Fergus Estuaries Special Protection Areas (SPA)

SCREENING MATRIX - River Shannon and River Fergus Estuaries Special Protection Areas (SPA)	
Brief description of the project or plan	To carry out maintenance dredging at both Ted Russell Dock, Limerick and Foynes Port, Foynes, Co. Limerick annually as required as per previous permits granted to SFPC.
Brief description of the *Natura 2000* Site	• The estuaries of the River Shannon and River Fergus form the largest estuarine complex in Ireland. The southern shoreline of the estuary is lined mostly by mud and sandflats together with intertidal areas. The inner section of the estuary, between Rineanna Point (Clare shore) and Beagh Castle (Limerick Shore) and Limerick City), is a large tidal system with intertidal mudflats, fringing reedbeds, swamps, polders, salt marsh and wet marsh habitats. For several of the bird species, it is the top site in the country. Also of note is that three of the species which occur regularly are listed on Annex I of the E.U. Birds Directive, i.e. Whooper Swan, Golden Plover and Bar-tailed Godwit. • This site is of great ornithological interest, being of international importance on account of the numbers of wintering birds it supports. The SPA provides good quality feeding and roosting areas for a range of wintering waterfowl. It supports internationally important numbers of three species of bird, Dunlin, Black-tailed Godwit and Redshank. A further 16 species have populations of national importance. Large numbers of some species such as the whimbrel and greenshank pass through the site whilst on migration in spring and/or autumn.
Describe the individual elements of the project likely to give rise to impacts on the Natura 2000 Site	The project comprises the following relevant activities: 1. Removal or dredging of sediment build up at both Ted Russell Dock and Foynes Port 2. Increased vessel movements during dredging and dumping. 3. Slight increase in operational noise levels during dredging operations

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SCREENING MATRIX - River Shannon and River Fergus Estuaries Special Protection Areas (SPA)	
Describe any likely direct, indirect or secondary impacts of the project (either alone or in combination with other plans or projects[2]) on the Natura 2000 Site by virtue of: - Size and scale - Land-take - Distance from the Natura 2000 Site or key features of the Site - Resource requirements (water abstraction etc.) - Emissions (disposal to land, water or air) - Excavation requirements - Transportation requirements - Duration of construction, operation, etc.	1. Dredging of approximately 150,000 tonnes annually which includes a contingency amount to cover exceptionally dry periods. This figure would be the absolute maximum quantity dredged in any year at Foynes Port. The dredging of approximately 120,000 tonnes annually which includes a contingency amount to cover exceptional periods. This figure would be the absolute maximum quantity dredged in any year at Limerick Dock. 2. The dredging operations could potentially increase the suspended sediment concentrations in the surrounding marine environment through the re-suspension of dredged material (in plumes) over the duration of the dredge phase. However, any potential increase in suspended solids would be temporary and localised to the dredge areas. 3. Accidental spills from plant and machinery during construction could lead to polluting substances entering the surrounding marine environment. 4. Noise would be emitted to air and to water during dredging works. 5. Increased vessel movements would occur during dredging, which could affect bird feeding.

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[2] Potential in-combination effects are considered in **Section 3.3**.

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SCREENING MATRIX - River Shannon and River Fergus Estuaries Special Protection Areas (SPA)	
Describe any likely changes to the Site arising as a result of: - Reduction of habitat area - Disturbance to key species - Habitat or species fragmentation - Reduction in species density - Changes in key indicators of conservation value (water quality etc.) - Climate change	1. Any temporary increase in suspended sediment levels during dredging could result in localised disturbance to fish species. 2. The deposition of sediment re-suspended by the dredging could affect benthic fauna species in the sub-tidal areas, which could alter the food resource density and diversity for wintering wildfowl and waders, and result in a change in bird populations. This affect could be significant if the sediment contains high levels of contaminants/pollutants. 3. Should they occur in an uncontrolled manner, accidental spillages of polluting substances could affect benthic fauna and reduce or affect the food resource for wintering wildfowl and waders. Possible long term pollution effects on over-wintering birds could also occur through the food chain. 4. Operational noise, in particular the dredger, could result in short-term disturbance to feeding birds over the duration of the dredging works. This could result in a change in bird populations in the short-term. 5. An increase in the number of vessels within the Port during dredging could disturb feeding birds in the short term.
Describe any likely impacts on the Natura 2000 Site as a whole in terms of: - Interference with the key relationships that define the structure of the Site - Interference with the key relationships that define the function of the Site	1. The structure and function of intertidal and subtidal feeding habitats could be affected by the re-suspension and deposition of sediment due to dredging and dumping, the deposition of dust, and (without appropriate risk control measures in place) accidental spills of polluting substances. This could affect bird populations in the short- to long-term. 2. Disturbance to feeding birds could theoretically occur as a result of the movement of dredgers and associated vessels and personnel.
Provide indicators of significance as a result of the identification of effects set out above in terms of: - Loss - Fragmentation - Disruption - Disturbance - Change to key elements of the Site (e.g. water quality etc.)	1. Amount of habitat disturbed, change in water quality, change to density of sediment 2. Degree of disturbance caused by dredger and associated vessels and personnel. 3. Degree of disturbance caused by operational noise.

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SCREENING MATRIX - River Shannon and River Fergus Estuaries Special Protection Areas (SPA)	
Describe from the above those elements of the project or plan, or combination of elements, where the impacts are likely to be significant or where the scale or magnitude of impacts is not known	The assessment indicates that *the potential exists* for an impact on the Site to arise as a result of the disturbance of sediment and its potential re-suspension in the vicinity of the Port and Dock together with a potential impact at the dump sites which may cause a disturbance to bird populations due to the proposed dredging schedule, prior to mitigation.

Table 3-6 SCREENING MATRIX – Lower River Shannon (SAC)

SCREENING MATRIX – Lower River Shannon (SAC)	
Brief description of the project or plan	To carry out maintenance dredging at both: Ted Russell Dock, Limerick and Foynes Port, Foynes, Co. Limerick annually as per previous permits granted to SFPC.
Brief description of the *Natura 2000* Site	The Lower Shannon SAC extends 120 km from Killaloe to Loop Head/ Kerry Head. The site thus encompasses the Shannon, Feale, Mulkear and Fergus Estuaries, the freshwater lower reaches of the River Shannon (between Killaloe and Limerick), the freshwater stretches of much of the Feale and Mulkear catchments and the marine area between Loop Head and Kerry Head. The site has been selected as a SAC for the presence of lagoons and alluvial wet woodlands, both habitats listed on Annex I of the E.U. Habitats Directive. The site is also selected for floating river vegetation, Molinia meadows, estuaries, tidal mudflats, Atlantic salt meadows, Mediterranean salt meadows, Salicornia mudflats, sand banks, perennial vegetation of stony banks, sea cliffs, reefs and large shallow inlets and bays all habitats listed on Annex I of the E.U. Habitats Directive. The site is also selected for the following species listed on Annex II of the same directive – Bottle-nosed Dolphin, Sea Lamprey, River Lamprey, Brook Lamprey, Freshwater Pearl Mussel, Atlantic salmon and Otter. A good number of Red Data Book species are also present, perhaps most notably the thriving populations of Triangular Club-rush.
Describe the individual elements of the project likely to give rise to impacts on the Natura 2000 Site	The project comprises the following relevant activities: 1. Removal or dredging of sediment build up at both Ted Russell Dock and Foynes Port 2. Increased vessel movements during dredging. 3. Slight increase in operational noise levels during dredging operations

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SCREENING MATRIX – Lower River Shannon (SAC)	
Describe any likely direct, indirect or secondary impacts of the project (either alone or in combination with other plans or projects[3]) on the Natura 2000 Site by virtue of: - Size and scale - Land-take - Distance from the Natura 2000 Site or key features of the Site - Resource requirements (water abstraction etc.) - Emissions (disposal to land, water or air) - Excavation requirements - Transportation requirements - Duration of construction, operation, etc.	1. Dredging of approximately 150,000 tonnes annually which includes a contingency amount to cover exceptionally dry periods. This figure would be the absolute maximum quantity dredged in any year at Foynes Port. The dredging of approximately 120,000 tonnes annually which includes a contingency amount to cover exceptional periods. This figure would be the absolute maximum quantity dredged in any year at Limerick Dock. 2. The dredging operations could potentially increase the suspended sediment concentrations in the surrounding marine environment through the re-suspension of dredged material (in plumes) over the duration of the dredge phase. However, any potential increase in suspended solids would be temporary and localised to the dredge areas. 3. Accidental spills from plant and machinery could occur during construction which could lead to polluting substances entering the surrounding marine environment. 4. Noise would be emitted to air and to water during dredging works. 5. Increased vessel movements would occur during dredging, which could affect bird feeding.

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[3] Potential in-combination effects are considered in **Section 3.3**.

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SCREENING MATRIX – Lower River Shannon (SAC)	
Describe any likely changes to the Site arising as a result of: - Reduction of habitat area - Disturbance to key species - Habitat or species fragmentation - Reduction in species density - Changes in key indicators of conservation value (water quality etc.) - Climate change	1. Any temporary increase in suspended sediment levels during dredging could result in localised disturbance to fish species which may have a knock on effect to the Bottlenose Dolphins. 2. Should they occur in an uncontrolled manner, accidental spillages of polluting substances could affect benthic fauna. 3. Operational noise, in particular the dredger, could result in short-term disturbance to cetaceans over the duration of the dredging/dumping works.
Describe any likely impacts on the Natura 2000 Site as a whole in terms of: - Interference with the key relationships that define the structure of the Site - Interference with the key relationships that define the function of the Site	1. The structure and function of intertidal and subtidal feeding habitats could be affected by the re-suspension and deposition of sediment due to dredging and dumping, the deposition of dust, and (without appropriate risk control measures in place) accidental spills of polluting substances. 2. Disturbance to feeding cetaceans could theoretically occur as a result of the movement of dredgers and associated vessels and personnel.
Provide indicators of significance as a result of the identification of effects set out above in terms of: - Loss - Fragmentation - Disruption - Disturbance - Change to key elements of the Site (e.g. water quality etc.)	1. Amount of habitat disturbed, change in water quality, change to density of sediment 2. Degree of disturbance caused by dredger and associated vessels and personnel. 3. Degree of disturbance caused by operational noise.

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SCREENING MATRIX – Lower River Shannon (SAC)	
Describe from the above those elements of the project or plan, or combination of elements, where the impacts are likely to be significant or where the scale or magnitude of impacts is not known	The assessment indicates that *the potential exists* for an impact on the Site to arise as a result of the disturbance of sediment and its potential re-suspension in the vicinity of the Port and Dock together with a potential impact at the dump sites which may cause a disturbance to cetaceans due to the proposed dredging schedule, prior to mitigation.

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3.3 CUMULATIVE CONSIDERATIONS – IDENTIFICATION OF LIKELY IMPACTS

In addition to assessing the potential impacts from the maintenance dredging programme, regard must also be paid to potential in-combination effects. The following should be considered as potentially having in-combination effects with maintenance programme:

- Foynes Port Land Reclamation Project;
- Shannon River Basin District Catchment Flood Risk Management Plan;
- Shannon River Basin Management Plan;
- Cumulative impact with other dredging operations in the Shannon Estuary
- General Impacts from the project
    - Direct loss of habitat and species/Reduction in the overall habitat available to protected species;
    - Temporary disturbance to species or habitats for which the Natura 2000 site is selected
    - Obstruction of fish migration
    - Increased suspended solids levels;
    - Disturbance to cetaceans;
    - Contamination from sediments

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3.4.1 Foynes Port Land Reclamation Project

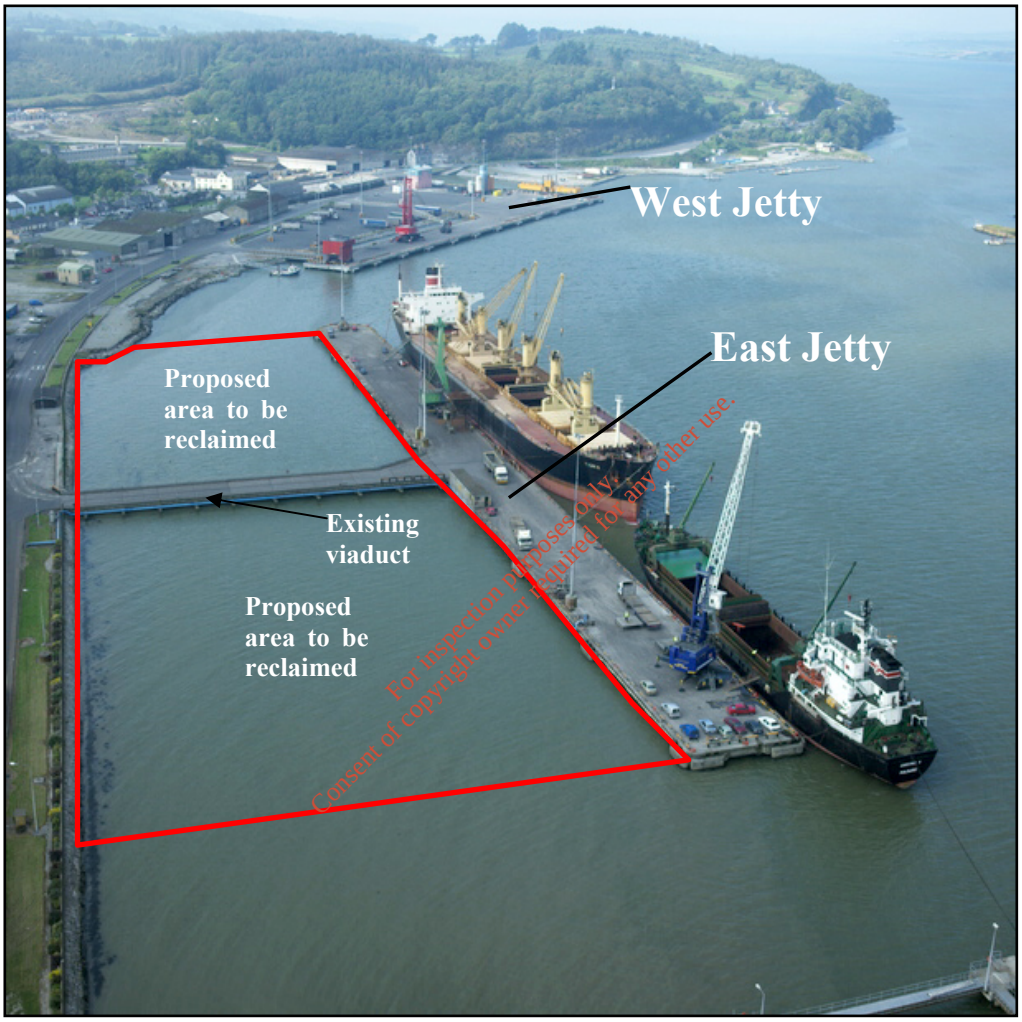
It is proposed to undertake a land reclamation project behind the existing East Jetty at Foynes Port. The proposed area to be reclaimed (Approximately 2.5ha) is an area of foreshore located behind the existing east jetty. This is an isolated jetty structure (The East Jetty) which has limited access to adequate handling and storage areas and as such all imports need to be transported to remote storage facilities. The reclamation works will be undertaken to the level of the existing structure at Foynes.

The proposed port development will therefore help to facilitate more flexible and efficient operations, improve operator safety and remove the bottle neck which is created on the viaduct during loading and off-loading. The reclaimed area will be surfaced and used for normal harbour operations and storage.

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Some dredging will be required prior to infilling the reclaimed area. The material used to infill the reclamation area will be imported and transported to the site largely by land.

The proposed works are not directly connected to, or necessary for, the management of the Natura 2000 site identified in this screening process. The reclamation project will be subject to a separate EIS and Appropriate Assessment which will accompany both the planning application to Limerick County Council and the Dumping at Sea Application to the EPA.



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Figure 3-8 Aerial Photograph showing Current Site Layout and proposed reclamation area at Foynes

3.4.2 Shannon IRBD Catchment Flood Risk Management Plan

The Shannon International River Basin District Catchment Flood Risk Management Plan (CFRMP), which is required in accordance with the EU Flood Directive (2007/60/EC), will include a set of prioritised studies, actions and works (structural and non structural) to manage the flood risk in the ShIRBD in the long-term, and will make recommendations in relation to appropriate development

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planning. The measures in the CFRMP could have cumulative impacts in combination with the flood alleviation works.

3.4.4 Shannon IRBD River Basin Management Plan

The Shannon International River Basin Management Plan, 2009-2015, outlines objectives and measures for all waters in the Shannon IRBD, one of which is to contribute to mitigating the effects of floods. The measures in the RBMP could have cumulative impacts in combination with the flood alleviation works.

3.4.5 Cumulative impact with other dredging operations in the Shannon Estuary

Dredging may take place at a number of other locations within the wider Shannon Estuary at the following locations:

- Moneypoint Power Station
- Endesa Ireland (Formerly Tarbert Power Station)
- Aughinish Aluminia
- Shannon Airport Jetty
- Kilrush Marina

The Department of the Marine and Natural Resources have delegated by legislation the management of marine navigation in the Shannon Estuary to the Shannon Foynes Port Company.

Dredging has not taken place at Moneypoint or Tarbert Power Stations since mid 2002 and therefore cumulative impacts with dredging and disposal from these facilities is not considered further. There are no deep water canyons in the Shannon Estuary suitable for bauxite residue disposal from Aughinish therefore disposal of bauxite residue in the Shannon Estuary does not take place. No dredging or disposal has ever been carried out at Shannon Airport Jetty or is proposed in the near future. The cumulative impact from other dredging operations in the Shannon Estuary is therefore screened out.

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3.4.6 General Impacts from the project

As a guide, any element of a plan or project that has the potential to affect the conservation objectives of a Natura 2000 site, including its structure and function, should be considered significant (EC, 2006). The potential negative impacts on the surrounding environment from the proposed works are:

- Direct loss of habitat and species/Reduction in the overall habitat available to protected species;
- Temporary disturbance to species or habitats for which the Natura 2000 site is selected (e.g. increased noise, general increase in human activity);
- Obstruction of fish migration

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- Increased suspended solids levels;
- Disturbance to cetaceans;
- Contamination from sediments

3.3.1.1 Direct loss of habitat and species/Reduction in the overall habitat available

The areas which are to be dredged are located within current highly active areas of both Ted Russell Dock and Foynes Port with both human activity and ship berthing on a regular basis. While there are potential prey items for waders and other shore birds in the inter-tidal habitats located **outside** of the areas which are included in the maintenance dredging application, the continuous turbulence of propellers from vessels entering and exiting the ports means the areas which are included in the maintenance application are largely impoverished and contain a very poor biological community. Therefore there will be no actual loss of foraging habitats or species and in particular no loss of inter-tidal mudflats from the proposed maintenance dredging operations as dredging will only take place in sub-tidal areas. In terms of ecological impact at the dump sites the deposition of 2cm of material on top of a biologically active seabed will smother the benthic fauna. It is evident; therefore, that one of the results of the maintenance dredging activities will be to destroy any infauna at the dump sites. Due however, to the fluctuating salinities which these sites experience in response to freshwater flows from the River Shannon the infauna at these sites is found in small numbers. Grab sampling previously undertaken by Aquafact at the dump sites found a total of 12 taxa present at the sites (1 nenatode, 5 polychaetes, 3 crustaceans and 3 bivalves). Aquafact found that the dumpsites are located in an area of the Shannon Estuary whose bottom features are neither unique nor critical to the overall habitat classification of this part of the estuary. Invertebrate species recorded such *as Streblospio shrubsolii*, *Bathyporeia pilosa* and *Cerastoderma glaucum* are common inhabitants of brackish waters in sheltered bays and estuaries such as the Shannon Estuary. The presence of polychaetes from the family Capitellidae such as *Capitella capitata* is a good indicator of organic enrichment and is tolerant of oxygen-stressed conditions. According to Connor et al. (1997) the most suitable classification for this habitat type is estuarine sublittoral muds (IMU.EstMu). These are shallow sublittoral muds, extending from the extreme lower shore to about 15m depth in estuarine conditions. Characterising species for this type of habitat such as *Streblospio shrubsolii* and *Capitella capitata* were recorded. Also, given the extensive areas of seabed surrounding the dump sites which are colonized by similar types of species, it is expected that re-colonization of the freshly deposited sediments will occur quite quickly. Therefore, it is considered that the direct loss of habitat and species/Reduction in the overall habitat available will not lead to a significant impact on the integrity of the Lower Shannon SAC or SPA and is therefore screened out.

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3.3.1.2 Temporary disturbance

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Temporary disturbance of protected species, potentially causing them to temporarily abandon their habitat may occur as a result of the increased noise and human activity levels associated with the dredging techniques. Any disturbance to wader species would be limited to low spring tides when dredging will not be carried out. In addition existing disturbance from Port activities already occurs on an on-going basis at both Limerick Dock and Foynes Port. Evidence clearly indicates that birds quickly adapt to noise and spatial disturbances caused by vessel movements and construction. Accordingly, additional disturbance from the works is predicted to have a short-term, negligible impact on bird use within the area of Limerick Dock or Foynes Port.

3.3.1.3 Obstruction of fish migration

In channel dredging if carried out at the time of upstream spawning migrations can have significant disrupting effects on salmon, trout and lamprey, causing them to spawn in sub-optimal locations and exposing salmonids to increased angling pressure. In the past the Port Company have been granted dump permits on the basis that there will be no dumping or dredging carried out between March 1st and June 30th of each year. This is to ensure that the operation has no negative impact on the migration of fish species in the Shannon Estuary for which it is designated. This recommended closure should again be adhered to should a maintenance permit be granted.

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3.3.1.4 Suspended Solids

Suspended sediment arising from disturbance of the channel bed by dredging and through construction can have severe negative impacts on invertebrate and plant life and on all life stages of fish. Fish spawning beds and other areas of fish habitat can be smothered. Fish gills can be abraded or clogged. The habitat of other aquatic organisms, such as invertebrates, can be smothered, thus reducing the amount of food available for fish. Also, suspended solids can reduce water clarity and visibility, impairing the ability of fish to find food.

The quantity of natural mud silt deposited annually in the some parts of the Shannon Estuary channel is significant especially during a wet summer as the large volume of fresh water coming down river scours away the silt along the upstream sectors of the channel. Summer quantities to be dredged can exceed 120,000 tonnes and this scenario requires continuous dredging from June until November annually.

To determine sediment loading from riverine inputs to the Shannon Estuary, monitoring data compiled from various National monitoring programmes was used. The various Local Authorities provided results of suspended solids analysis from rivers sampled in compliance with the Water Framework Directive. The Environmental Protection Agency (EPA) provided data compiled for the Comprehensive Study of Riverine Inputs undertaken by the EPA for purposes of the Convention for the Prevention of Marine Pollution from Land Based Sources (Paris Convention). Consequent on the amalgamation of the Paris and Oslo Conventions, the name of the Convention was changed to the OSPAR Convention.

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The EPA provided flow data from which estimates are made of the annual loads of various pollutants carried by rivers discharging to the seas around Ireland.

Flow data are derived from water level records and the stage (water level) discharge relationship i.e. the station's rating curve developed for the staff gauge at the station. The methodology used in OSPAR report the project is to obtain the flow (and loading) at time of water quality sampling and, based on the continuous water level records, to estimate the flow (and estimate the loading) to the seas throughout the year.

The main riverine (and sediment) inputs to the Shannon Estuary were included in the assessment of sediment loading, based on availability of monitoring data. These include the Rivers: Shannon, Fergus, Deel, Maigue and Mulkear. There are smaller riverine inputs to the estuary that are not monitored and therefore sediment loading from these cannot be included in these sediment load calculations.

Catchment Flows

Flow rates at the water quality sampling stations and at the catchment mouths have been determined by extrapolation, on an area basis, of flow data as determined for the hydrometric stations by the EPA.

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RIVER CATCHMENT	HYDROMETRIC STATION	SAMPLING STATION	LONG AVERAGE FLOW m^3/s
Deel	24013 Rathkeale 24029 Inchirourke More	Rathkeale Askeaton	7.36
Maigue	24008 Castleroberts 24001 Croom	Castleroberts Croom	17.35
Fergus	27002 Ballycorey	Doora	19.00
Shannon (to Limerick)	25055 Ardnacrusha P.S. 25075 Parteen 25044 Coole 25001 Annacotty	Athlukard	208.96

Table 3-7 Details of Hydrometric Stations, sampling stations and flow from riverine inputs.

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Sediment concentrations

Monitoring data associated with the Water Framework Directive monitoring programme was made available from Limerick and Clare County Councils.

RIVER CATCHMENT	SAMPLING STATION	SUSPENDED SOLIDS mg/l (Average)
Deel	Rathkeale Askeaton	6.2
Maigue	Castleroberts Croom	6.25
Fergus	Doora	3.18
Shannon (to Limerick)	Athlukard	3.04

Table 3-8 Details of suspended solids concentration from riverine inputs

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The loading calculation are derived simply by multiplying the total flow by the concentration i.e. mg/l by total no litres, as outlined in table 3.8.

RIVER CATCHMENT	SUSPENDED SOLIDS mg/l (Average)	LONG AVERAGE FLOW l/s	SUSPENDED SOLIDS LOADING mg/s	SUSPENDED SOLIDS LOADING kg/d
Deel	6.2	7,360	45,632	3,943
Maigue	6.25	17,350	108,438	9,369
Fergus	3.18	19,000	60,420	5,220
Shannon (to Limerick)	3.04	208,960	635,238	54,885

Table 3-9 Loading of suspended solids from riverine inputs

In total, an average of 73,417 kgs of suspended solids a day enters the Shannon estuary from the riverine inputs monitored. While this assessment only looks at some of the main rivers entering the Lower River Shannon and therefore provides an underestimation of the total suspended solids entering the system on a daily basis it does provide a very clear indication that the overall sediment load in the Lower River Shannon will not be effected by the maintenance dredging works with no net loss to the system. As outlined in 3.4.5 above dredging operations at other locations within the Lower

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River Shannon have not taken place since 2002 with no immediate need for dredging identified this impact is not considered further. As outlined in Section 3.1.2.1 the natural level of sedimentation and accretion which occurs in the estuary on a daily basis necessitates the requirement for maintenance dredging. In the absence of such operations within a highly erosive and naturally depositing system could lead to deleterious effects on the excellent examples of Annex 1 habitats located elsewhere in the estuary.

3.3.1.5 Disturbance to cetaceans

Dolphins are curious by nature and while they are not usually found in the immediate vicinity of the port any increased or new operations may lend to their curious nature bringing them closer to the Port. Acoustics is the most important sense for cetaceans, and the ability to hear well is vital in all key aspects of their lives including finding food, navigating and social interactions (Richardson et al. 1995). Any reduction in hearing ability, whether by physical damage or masking by other sound, may seriously compromise the viability of individuals and, therefore, populations. Similarly, during dumping operations dolphins may become curious and encroach on the dump site diving at the time of dumping from the dredger or barge leading to a direct impact. The adopted JNCC codes of practise and mitigation measures which NPWS now adhere to will be adopted throughout both dredging and dumping at sea operations. These will be looked at further under Section 4.2.1 - Mitigation Measures.

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3.3.1.6 Contamination from sediments

As part of the maintenance dredging operations it is imperative that no contamination from sediments occurs during the dredging operations at either Limerick Dock or Foynes Port. Sediment analysis should demonstrate that the material which is being dredged will have no radiological or chemical impact on the aquatic environment. Previous Sediment and Radiological Analysis indicate that at present the qualities and quantities of the material being dumped in the Shannon Estuary both from Limerick and Foynes is not deleterious to the area of the dump sites. The results from all samples taken from both Foynes and Limerick Dock concluded that dumping the material at sea would not result in a radiological hazard. The results and findings from these reports can be found in Appendix D of the Dumping at Sea Application.

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3.4 SCREENING CONCLUSIONS

The likely impacts that will arise from the proposed works have been examined in the context of a number of factors that could potentially affect the integrity of the Natura 2000 network. On the basis of the findings of this Screening for Appropriate Assessment, it is concluded that the proposed works:

(i) are not directly connected with or necessary to the management of a Natura 2000 site and

(ii) may have significant effects on the qualifying species of the River Shannon and River Fergus SPA and the Lower River Shannon SAC.

(iii) will not effect

SPA Code 004161	Stack's to Mullaghareirks, West Limerick Hills and Mount Eagle SPA
SAC Code 000064	Poulnagordon Cave (Quin)
SAC Code 000030	Danes Hole, Poulnalecka
SAC Code 002319	Kilkishen House
SAC Code 002316	Ratty River Cave
SAC Code 000051	Lough Gash Turlough
SAC Code 001013	Glenomra Wood
SAC Code 002279	Askeaton Fen Complex
SAC Code 000174	Curraghchase Woods
SAC Code 000432	Barrigone
SAC Code 000439	Tory Hill

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Therefore, applying the precautionary principle, and in accordance with Article 6(3) of the Habitats Directive, the process must proceed to Stage 2 - Appropriate Assessment.

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4 STAGE 2 - APPROPRIATE ASSESSMENT

The appropriate assessment stage involves the following:

i. Prediction of impact of plan or project.

ii. Assessment of effects of plan or project on the integrity of Natura 2000 sites.

iii. Identification of mitigation measures.

4.1 IMPACT PREDICTION

4.1.1 Ecological Impacts

Potential Impacts on the Lower River Shannon SAC

In the absence of adequate mitigation, maintenance dredging will have the following potential impacts:

1. Suspended solids and other pollutants generated by the dredging works could have negative impacts on downstream flora and fauna, particularly on salmonids, lamprey and cetaceans.
2. Dumping of dredge spoil from both Limerick Dock and Foynes Port also has the potential for contamination of the River Shannon with suspended solids and other construction generated pollution in the absence of mitigation measures.

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Potential Impacts on the River Shannon and River Fergus SPA

In the absence of adequate mitigation, maintenance dredging operations will have the following potential impacts:

1. Disruption and disturbance to birds feeding within the vicinity of the Dock and Port.
2. Direct release of sediment from the dredging operations to the habitats within the SPA that are of importance to qualifying species.

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4.1.2 Hydrological Impacts

The proposed scheme is not likely to significantly affect water levels and water velocity in the river under normal flow conditions. However, during flood events, due to the increased depth of water the carrying capacity will increase and the conveyance will be improved. Thus, decreasing the risk of localised flood events in the surrounding area.

The proposed works are not expected to have any impacts on groundwater hydrology as the works will not involve excavation to bedrock.

4.1.3 Cumulative Impacts

The areas where the proposed dredging is to take place have been subject to maintenance dredging on numerous occasions over the past number of years.

There are likely to be cumulative impacts associated with the Foynes Land Reclamation Project. However given that this will only impact on the Lower Shannon SAC as Foynes lies outside the River Shannon and River Fergus SPA, the mitigation measures put forward will ensure no negative impact on the integrity of the cSAC.

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Some of the potential impacts associated with the works, such as sedimentation, are likely to be exacerbated by possible effects associated with climate change (such as more frequent and more severe flooding). However, the dredging operation will ensure the conveyance of flood waters is more efficient given the improved depths at the facilities. This should ensure the integrity of the cSAC.

The Shannon International River Basin Management Plan, 2009-2015, outlines objectives and measures for all waters in the Shannon IRBD, one of which is to contribute to mitigating the effects of floods. The potential impacts of the dredging works should be considered in combination with the effects of implementation of the River Basin Management Plan. The requirements of the River Basin Management Plan should be considered when planning and implementing the food relief works.

The Shannon International River Basin District Catchment Flood Risk Management Plan (CFRMP), when it is developed, will include a set of prioritised studies, actions and works (structural and non structural) to manage the flood risk in the ShIRBD in the long-term, and will make recommendations in relation to appropriate development planning. It will be a strategic document and will not incorporate detailed designs for individual flood risk management measures. The objectives of the CFRMP, and consequently the EU Floods Directive, should be considered when planning and constructing the reclamation works.

All other cumulative impacts listed in 3.4.6 have been screened out.

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4.2 ASSESSMENT OF EFFECTS OF PLAN OR PROJECT ON THE INTEGRITY OF NATURA 2000 SITES.

4.2.1 Water Framework Directive Findings

Many of the qualifying interest features listed for the Lower River Shannon SAC and River Shannon and Fergus SPA are either water dependant habitats or species[4] and therefore the water quality requirements for these features have strict protection under the Water Framework Directive (WFD). Article 6 of the Water Framework Directive requires member states to compile a Register of Protected Areas for water-dependent habitats and species lying within each river basin district. This register takes account of Natura 2000 sites and affords them protection through the WFD. The Water Framework Directive (WFD) and the relevant Common Implementation Strategy (CIS) Guidance define Heavily Modified Water Bodies (HMWBs) as bodies of water which, as a result of physical alterations by human activity, are substantially changed in character and cannot, therefore, meet "good ecological status" (GES). Instead of "good ecological status" the environmental objective for HMWB and is good ecological potential (GEP), which has to be achieved by 2015.

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As part of the implementation of the Water Framework Directive and the development of the Shannon International River Basin District IRBD) Management Plan one transitional water body in the Shannon IRBD was identified as a Heavily Modified Waterbody (HMWB) associated with the port and related activities at Limerick; the water body name is Limerick Dock (water body ID: SH_060_0900) where Ted Russell Dock, Limerick is located. It was identified due to the presence and scale of operations at Limerick Dock and its related shipping and dredging activity in the shipping channel. The water body area is 2.5km^2. It is typed as TW2 which describes it as meso or polyhaline, strongly mesotidal and sheltered. The water body extends from Corbally Bridge to Coonagh Point, downstream of the city. The current annual throughput at Limerick port is 550,000 tonnes.

The water body is modified for the purposes of port activity as follows:

- reinforcement of coastline by quay walls, including an enclosed dock with over 900m of quay. Note: shoreline reinforcement is present upstream of the port and shipping channels also.
- altered hydrological regime due to shipping movement to and from Limerick Docks
- altered bed morphology, hydrological and sediment regime due to dredging of turning basins and the shipping channel.

Water quality and risk class:

[4] http://www.ria.ie/RIA/files/ab/abe05d1e-1595-42df-85ca-5dc1de910e58.pdf

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The water body was reported as being at intermediate trophic status for the last two EPA sampling periods ('99-'03 and '01-'05). For the '95 – '99 sampling period, a status of 'unpolluted was reported. An overall risk class of 1a: At Risk was determined for this water body under the Article 5 Risk Assessments. The water body was determined to be "At Risk" due to the presence and scale of the port and also due to point sources (combined storm overflows and non-compliant IPPC licensed industries) and pollution as determined by a review of existing monitoring data.

The proposal to designate Limerick Dock due to modifications for Limerick port was approved by the HMWB & AWB POMS Study Steering Group in October 2007.

At the same time one transitional water body in the Shannon RBD was identified as a HMWB associated with the presence and scale of port operations at Foynes; Foynes Harbour (water body ID: SH_060_0350). The water body area is 0.75km^2. It is typed as TW2 which describes it as meso or polyhaline, strongly mesotidal and sheltered. The water body is between the southern shore of Foynes Island and the mainland in the Shannon Estuary, 35km downstream from Limerick. In 2005, Foynes Harbour handled 1.6 million tonnes of cargo, representing an increase in throughput of more than 9% on the previous year.

The Foynes Harbour water body is modified for the purposes of port activity as follows:

- Reinforcement of coastline by quay walls and land claim through installation of concrete and steel harbour berths and jetties.
- altered hydrological regime due to movement of large vessels to & from harbour
- altered bed morphology, hydrological and sediment regime due to dredging of turning basins and the approaching shipping channel.

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Water quality and risk class:

The Foynes Harbour water body was not reported on as a discrete water body in EPA water quality reports. The adjacent Lower Shannon Estuary water body was reported as being unpolluted in the three sampling periods since 1999. An overall risk class of 1a: "At Risk" was determined for this water body under the Article 5 Risk Assessments. The water body was determined to be "At Risk" due to the presence of the port. Risk ratings of 1b: 'probably at risk' were assigned due to a Waste Water Treatment Plant and morphological pressure due to intensive land use.

The process involved a hydromorphological assessment for classification. The United Kingdom Technical Advisory Group (UK TAG) published its Guidance on the Classification of Ecological Potential for HMWBs which was utilised by Ireland. The approach involves an assessment of mitigation measures as an alternative approach for hydromorphological classification. This measures-based hydromorphological class is combined with the physico-chemical and biological class for the water body to determine the final Ecological Potential class for the HMWB.

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For measures, in short, where it is discovered that all practicable measures compatible with the use being made of the water body are already in place and effective, a 'Good Ecological Potential or Better' class is assigned. Where opportunities for the implementation of additional measures are identified, 'Moderate Ecological Potential or Worse' is assigned.

Both waterbodies containing Limerick Dock and Foynes Port were classified as being at **"Good Ecological Potential or better"** which therefore implies all practical measures are being undertaken to ensure the water quality status is maintained for the qualifying interest features of both the SAC and SPA.

A summary of the findings from the classification process can be found in Appendix B. In terms of the maintenance permit application the most applicable information relates to the findings from the Maintenance Dredging pressure and the Dredged Material Disposal pressure which is outlined below.

Limerick Dock

Firstly in terms of the Physical disturbance due to removal of sediment or re-deposition of disturbed sediment; increased suspended sediment in water column; change in flows; change in wave propagation; change in sediment transport and direct or indirect habitat loss or change the classification process found that the measures which SFPC are currently operating are adequate and will provide more than a slight ecological benefit when considered alone or in combination with other measures. The current trailer suction dredger operates using a head which causes minimal agitation. The suction head is kept as close as possible to the mud in order to maximise the operation which leaves no room for re-suspension. Secondly in terms of smothering due to deposition of sediment; disturbance due to deposition of re-suspended sediment; increased suspended sediment in water column and direct habitat loss or change due to disposal the classification process found the measures which SFPC are currently operating are adequate and will provide more than a slight ecological benefit when considered alone or in combination with other measures. As part of the previous Dump at Sea permit application process it is approved by the MLVC. Members from NPWS & the Marine Institute (MI) sit on this board that approved the dump site selection keeping in mind it's designation as an SPA/SAC. Also dredging is generally restricted between the months of February – June which will minimise impact on key habitats and species.

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Foynes

Similar to Limerick Dock Foynes classification found that the measures which SFPC are currently operating are adequate and will provide more than a slight ecological benefit when considered alone or in combination with other measures. Operations are carried out in such a way as to minimise the impact within the SAC and SPA. These include varying the dumping of dredge material within the dump site coupled with the dredging method. As part of the previous Dump at Sea permit application process it is approved by the MLVC. Members from NPWS & the Marine Institute (MI) sit on this board that approved the dump site selection keeping in mind it's designation as an SPA/SAC. Also dredging

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is generally restricted between the months of February – June which will minimise impact on key habitats and species.

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Table 4-1 Assessment of the Implications of the Maintenance Dredging operations on the River Shannon and River Fergus Estuaries Special Protection Area (SPA)

River Shannon and River Fergus Estuaries Special Protection Areas (SPA)	
Designated Site Description	
Brief Description of the Natura 2000 site	The estuaries of the River Shannon and River Fergus form the largest estuarine complex in Ireland. The southern shoreline of the estuary is lined mostly by mud and sandflats together with intertidal areas. The inner section of the estuary, between Rineanna Point (Clare shore) and Beagh Castle (Limerick Shore) and Limerick City), is a large tidal system with intertidal mudflats, fringing reedbeds, swamps, polders, salt marsh and wet marsh habitats. For several of the bird species, it is the top site in the country. Also of note is that three of the species which occur regularly are listed on Annex I of the E.U. Birds Directive, i.e. Whooper Swan, Golden Plover and Bar-tailed Godwit. This site is of great ornithological interest, being of international importance on account of the numbers of wintering birds it supports. The SPA provides good quality feeding and roosting areas for a range of wintering waterfowl. It supports internationally important numbers of three species of bird, Dunlin, Black-tailed Godwit and Redshank. A further 16 species have populations of national importance. Large numbers of some species such as the whimbrel and greenshank pass through the site whilst on migration in spring and/or autumn.
Conservation objectives for the designated Natura 2000 site	The main conservation objective for the designated Natura 2000 site as set out by the National Parks and Wildlife Service (NPWS) is as follows: **Main objective:** To maintain the special conservation interests for this SPA at favourable conservation status: comorant; light-bellied brent goose, shelldduck, wigeon, teal, ringed plover, golden plover, grey plover, lapwing, knot, dunlin, black-tailed godwit, bar-tailed godwit, curlew, redshank, greenshank, 20,000 wintering waterbirds, whooper swan, pintail, shoveler, scaup, black-headed gull, wetland & waterbirds.
Screening Appraisal	
Describe how the project (alone or in-combination) is likely to affect the Natura 2000 site.	The key phase of this project which has the greatest potential to give rise to effects upon the River Shannon and River Fergus Estuaries SPA is the dredging operations at Limerick Dock and Foynes Port, the main risks being: 1. Disruption and disturbance to birds feeding within the vicinity of the Dock and the Port 2. Direct release of sediment from the dredging operations to the habitats within the SPA that are of importance to qualifying bird species.

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Explain why the effects are **not** considered significant.

On site activity from the **dredging operations** including the dredger itself and any associated barges, tugs etc will give rise to noise and visual disturbance potentially resulting in disturbance to wintering and breeding bird species. As no areas of inter-tidal mudflats, saltmarshes or habitats of a similar nature are located within the dredge or dump sites this is not considered to have a significant effect on the integrity of the SAC or SPA as no loss of potential bird feeding areas will occur.
Birds in the SPA are habituated to traffic within Limerick Dock and Foynes Port as cranes operate and large ships dock on a daily basis within the Dock and Port leading to the movement of lorries in and out of the Ports as they un-load their cargo. The increase of disturbance to feeding birds will be minimal as no increase in road traffic will take place with only the dredger operating within the vicinity of the ports. Therefore the increase in disturbance to species in the River Shannon and River Fergus Estuaries SPA is not expected to be significantly different from current conditions of which are not known to result in any impacts to the qualifying birds. Impacts are not likely to be significant and therefore are not expected to have an adverse effect on the integrity of the SPA.

The level of risk from the direct release of sediment from the dredging operations is substantially lower than existing risks from the continuous churning of sediment in the river channel from propellers as ships entry and exit the ports.The physical damage (siltation & extraction) can lead to the removal of benthic animals at the dredge site and temporary increases in the level of suspended sediments in the water column that may cause potential impacts such as;

-disturbance to sensitive marine life,
-oxygen depletion due to release of organic material,
-uptake of contaminants by marine life,
-smothering of benthic communities

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These impacts can be mitigated against using best practise guidelines and by applying strict codes of practise to ensure any short term impacts are kept to a minimum.

The removal of benthic animals is unavoidable, however the communities within regularly dredged channels (Which Foynes and Limerick Dock both are) are regularly degraded or impoverished and there is relatively rapid recovery. The suspension of sediments is inevitable however the effects tend to be short term (<1 week after dredge activity) and near-field (<1km from activity). Dredging often generates no greater suspended sediments than natural events or other human activities such as the docking of large vessels at the ports. Impacts are not likely to be permanent and are not expected to have an adverse effect on the integrity of the SPA.

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	Similar to the dredging operations impacts at disposal site also need to be considered. Physical damage such as siltation and smothering may occur from the disposal of dredged material at sea. This can cause smothering of benthic communities which the birds feed on and cause disturbance. Smothering is inevitable at disposal sites however as the communities within regularly used sites (such as the approved dump sites which SFPC use) are often utilised the infauna will have previously been impaired and colonized other areas outside of the immediate dump zones. Potential negative effects will be mitigated by varying the location of the dumped material throughout the dump site, by having limitations on the volumes which can be dumped throughout the day and also the dumping will be minimised under the restrictions and guidance set out in the dump at sea permit. It is therefore anticipated that the effects on the integrity of the SPA will not be affected. Taking a combination of the proposed mitigation measures (described in section 4.2.1) the magnitude of the impacts and the proposed works into account, it is anticipated that the status of the special conservation interests fro this SPA will not be compromised as no impacts are likely to have an adverse effect on the integrity of the site.
Is the plan/project likely to have a significant effect on the Natura 2000 sites, either alone or in combination, with other plans or projects?	It is considered that the proposed development taking all detailed mitigation measures into account is not likely to have a significant effect on the SPA, either alone or in combination with other plans or projects.

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Table 4-2 Assessment of the Implications of the Maintenance Dredging operations on the Lower River Shannon (SAC)

Lower River Shannon SAC	
Designated Site Description	
Brief Description of the Natura 2000 site	The full extent of the cSAC is of great ecological interest as it contains a high number of habitats and species listed on Annexes I and II of the E.U. Habitats Directive, including the priority habitat lagoon. Most of the estuarine part of the site has been designated a Special Protection Area (SPA), under the E.U. Birds Directive, primarily to protect the large numbers of migratory birds present in winter. The qualifying interests (habitats) of the candidate SAC are as follows - Estuaries - Mudflats and sandflats not covered by seawater at low tide - Coastal lagoons - Vegetated sea cliffs of the Atlantic and Baltic coasts - Salicornia and other annuals colonizing mud and sand - Atlantic salt meadows (Glauco-Puccinellietalia maritimae) - Mediterranean salt meadows (Juncetalia maritimi) - Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation - Sandbanks which are slightly covered by sea water all the time - Large shallow inlets and bays - Reefs - Perennial vegetation of stony banks - Spartina swards (Spartinion maritimae) - Molinia meadows on calcareous, peaty or clavey-silt-laden soils (Molinion caeruleae) - Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae) The qualifying interests (species) of the candidate SAC are as follows - Lampetra fluviatilis - Lampetra planeri - Lutra lutra - Margaritifera margaritifera - Petromyzon marinus - Salmo salar - Trusiops truncatus

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Conservation objectives for the designated Natura 2000 site	The conservation objectives for the designated Natura 2000 site as set out by National Parks and Wildlife Service (NPWS) are as follows: **Objective 1:** To maintain the Annex I habitats for which the cSAC has been selected at favourable conservation status: Large shallow inlets and bays; Estuaries; Salicornia and other annuals colonising mud and sand; Vegetated sea cliffs of the Atlantic and Baltic coasts; Mediterranean salt meadows (Juncetalia maritimi); Coastal lagoons; Mudflats and sandflats not covered by seawater at low tide; Atlantic salt meadows (Glauco-Puccinellietalia maritimae); Sandbanks which are slightly covered by sea water all the time; Reefs; Perennial vegetation of stony banks; Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation; Molinia meadows on calcareous, peaty or clavey-silt-laden soils (Molinion caeruleae); Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae). **Objective 2:** To maintain the Annex II species for which the cSAC has been selected at favourable conservation status: • Lampetra fluviatilis • Lampetra planeri • Petromyzon marinus • Salmo salar • Margaritifera margaritifera; • Tursiops truncates • Lutra lutra. **Objective 3:** To maintain the extent, species richness and biodiversity of the entire site. **Objective 4:** To establish effective liaison and co-operation with landowners, legal users and relevant authorities. **Objective 5:** To maintain the favourable conservation condition of Lagoons in Lower River Shannon cSAC
Screening Appraisal	
Describe how the project (alone or in-combination) is likely to affect the Natura 2000 site.	The potential impacts resulting from the maintenance dredging operations include: 1. General dredging stage disturbance to species 2. Direct release of sediment from the dredging operations to Annex 1 habitats and Annex II species within the SAC that are of importance to the site integrity.
Explain why the effects are not considered significant.	On site activity from the **dredging operations** including the dredger itself and any associated barges, tugs etc will give rise to noise and visual disturbance potentially resulting in some slight disturbance to Annex II species.

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These species are habituated to traffic within Limerick Dock and Foynes Port as cranes operate and large ships dock on a daily basis within the Dock and Port leading to the movement of lorries in and out of the Ports as they un-load their cargo. The increase of disturbance to fish species, otter and cetaceans will be minimal as no increase in road traffic will take place with only the dredger operating within the vicinity of the ports. *In addition when the Port Company in the past has been granted dump permits it is on the basis that there will be no dumping or dredging carried out between March 1st and June 30th of each year. This is to ensure that the operation has no negative impact on the migration of fish species in the Shannon Estuary.* SFPC will again operate within these restrictions. Hearing is the most important sense for cetaceans, and the ability to hear well is vital in all key aspects of their lives including finding food, navigating and social interactions (Richardson et al. 1995). Any reduction in hearing ability, whether by physical damage or masking by other sound, may seriously compromise the viability of individuals and, therefore, populations. Whilst at an extreme level noise can lead to cetacean mortality from barotrauma, sub-lethal effects may also have a significant impact (Crum & Mao, 1996; Frantiz, 1998). A condition of the dumping at sea act (1996) which the dump at sea permit is applied under requires an independent observer, with relevant expertise, to accompany the dredge/dump vessel to monitor and record activity of dolphins during the duration of the works to which the permit relates. As the Shannon estuary is a candidate Special Area of Conservation (SAC) for bottlenose dolphins *Tursiops truncatus,* it will be a condition of the permit that a buffer zone of 2.5km (approx. 1.4 nautical miles) shall be imposed around the dredge/dump vessel and all dredging/dumping will be suspended if dolphin activity occurs within this zone (for the duration that such activity occurs within this zone). In compliance with the disposal at Sea Act (1996) Shannon Foynes Port Company will again employ an independent observer for the duration of the works to ensure no negative impacts to the bottlenose dolphin and overall ensure the integrity of the site is not compromised. In relation to Otters they are mainly nocturnal with their main peaks of activity around 3-5 hours after dusk and just before dawn. They can be seen during the day in isolated parts of the countryside where there is minimal disturbance from man. Dredging operations in Limerick Dock are generally carried out in the hours of daylight and as Otters are mainly nocturnal this should avoid any negative impact to the species. Subject to the conditions of the EPA Dumping at Sea permit dredging may continue around the clock at Foynes Port. Otter surveys commissioned by SFPC and carried out by Dr. Simon Berrows in April and June 2010 found no indication of Otter presence either through direct sightings or through the presence of spraints and/or other signs of otter activity, which is consistent with the methodology described in Bailey and Rochford (2006).

Therefore the increase in disturbance to species in the Lower Shannon SAC is not expected to be significantly different from current conditions of which are not known to result in any impacts to the qualifying features. Impacts are not likely to be significant as they are not expected to have an adverse effect on the integrity of the SAC.

The level of risk from the direct release of chemicals/oils/petrols etc from the dredging operations is substantially lower than existing risks from the spillage of fluids from marine and river vessels. Should such a pollution event occur in the absence of mitigation measures it may lead to;

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- disturbance to sensitive marine life,
-nutrient enrichment possibly increasing algal growth & increasing food supplies,
- uptake of contaminants by marine life,

A full work methodology should be developed prior to the commencement of any on site works which should detail the correct procedures for storage of all chemicals and fluids on-site. It should also outline the correct procedure for refuelling all machinery on-site away from watercourses.
Chemical analysis of sediment in Limerick (Enclosed dock and Approach Channel) together with Foynes has been undertaken by Enterprise Ireland Shannon Laboratory. The results from all three locations show that the level of contamination found is generally low and compares to those at other ports. Equally the radiological analysis carried out by the Radiological Protection Institute found that the dumping of these materials at sea will not result in a radiological hazard. The results from these investigations can be found in Section F of the Dumping at Sea Application. Shannon Foynes Port Company are part of a consortium consisting of the Port Company, Local Authorities and oil importers and was initiated to form a unified coordinated response to pollution incidents on the Shannon Estuary (Shannon Estuary Anti-Pollution Team SEA-PT). Each member contributed initially to provide pollution response equipment and support tools. This equipment is available to respond to any pollution incident or threat. Members contribute annually to maintain equipment, carry out exercises and training and purchase new and replacement equipment.

The group has been in operation for the past 10 years under a committee of pollution officers representing the members. The aim of the group is to provide a unified response to oil pollution within the region, even though each member has individual responsibility for their own area. An Oil Spill Tracking Model, Geographic Information System, Environmental Atlas, Sensitivity Study, Oil Spill Response Strategy, Hydrocarbon Baseline Study and Emergency Response Plans have been developed for the region and updated.

The Pollution Control Plan http://www.seapt.ie/ is provided to assist the Shannon Estuary Ports Anti-Pollution Team (SEA-PT) in dealing with an accidental discharge of oil. Its primary purpose is to set in motion the necessary actions to stop or minimise the discharge and to mitigate its effects. Effective planning ensures that the necessary actions are taken in a structured, logical and timely manner. This plan guides the Coordinator and On Scene Commander and other involved personnel through the decisions, which will be required in an incident response. The tables, figures and checklists provide a visible form of information, thus reducing the chance of oversight or error during the early stages of dealing with an emergency situation. For the plan to be effective, it must be:

- familiar to those with key response functions in the ports
- regularly exercised; and,
- reviewed and updated on a regular basis.

All contractors and operators working in the vicinity of Shannon Foynes Port Company and Limerick Dock

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should be made fully aware of the Pollution Control Plan prior to commencing any works on site.

The removal of benthic animals is unavoidable; however the communities within regularly dredged channels (which Foynes and Limerick Dock both are) have shown a relatively rapid recovery. The suspension of sediments is inevitable however the effects tend to be short term (<1 week after dredge activity) and near-field (<1km from activity). Dredging often generates no greater suspended sediments than natural events or other human activities such as the docking of large vessels at the ports. Impacts are not likely to be permanent and are not expected to have an adverse effect on the integrity of the SAC.

Similar to the dredging operations impacts at disposal site also need to be considered. Physical damage such as siltation and smothering may occur from the disposal of dredged material at sea. This can cause smothering of benthic communities which the birds feed on and cause disturbance. Smothering is inevitable at disposal sites however as the communities within regularly used sites (such as the approved dump sites which SFPC use) are often degraded the impact at the dump site is not thought to pose a significant impact. Aqua-fact International Ltd were commissioned by Shannon Foynes Port Company to carry out an impact assessment study of the environmental effects of maintenance dredging in the Shannon estuary and subsequent disposal of the dredged material in the approved dump sites in the estuary. While the deposition will take place on a biologically active seabed which will smother the benthic infauna, re-colonisation of the freshly deposited sediments will occur quite quickly as there are extensive areas of seabed in the vicinity of both sites which are colonised by the same types of species. (Full report can be found in Section D of the Dumping at Sea Application) Potential effects will be mitigated by vary the location of the dumped material throughout the dump site, by having limitations on the volumes which can be dumped throughout the day and will also be minimised under the restrictions and guidance set out in the dump at sea permit. It is therefore anticipated that the effects on the integrity of the SAC will not be affected.
Taking a combination of the proposed mitigation measures (described above in section 4.2.1) the magnitude of the impacts and the proposed works into account, it is anticipated that the status of the special conservation interests for this SAC will not be compromised as no impacts are likely to have an adverse effect on the integrity of the site.

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Is the plan/project likely to have a significant effect on the Natura 2000 sites, either alone or in combination, with other plans or projects?	It is considered that the proposed development is not likely to have a significant effect on the SAC, either alone or in combination with other plans or projects.

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4.1.4 Consultation

- The Department of Environment, Heritage and Local Government Appropriate Assessment guidelines recommend that consultation is undertaken with that Department. In accordance with this recommendation, a programme of consultation was undertaken with Inland Fisheries Ireland (IFI), Limerick and the National Parks and Wildlife Services.

- Initial consultation letters were issued to both authorities outlining the requirements of the dump at sea application. Subsequently, telephone consultation was undertaken with Dr Jervis Good, Divisional Ecologist, NPWS (Southern Division) and also indirectly through a multi-agency meeting of users within the estuary to discuss dredging operations attended by both NPWS and IFI. His preliminary comments were taken on board and considered during the preparation of the Appropriate Assessment. Consultation correspondence are contained in Appendix C

- Following the completion of the Article 6 Habitats Directive Appropriate Assessment report a hard copy of it will be provided to the Development Applications Unit of the Department of the Environment, Heritage and Local Government together with Inland Fisheries Ireland for comment by the EPA during their assessment process.

- Any comments which are provided will be addressed within the final version of this report.

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4.2.1 Summary of Mitigation Measures which should be implemented as part of the Dumping at Sea Permit

An overall general recommendation is that a policy of no dredging should take place within fish migration periods or avian over-wintering seasons. Consideration should be given to potential negative impacts from the maintenance dredging operations prior to the commencement of works and appropriate mitigation measures should be applied where necessary.

Works should only be carried out after a method statement; detailed plans and timing of works have been agreed with the National Parks & Wildlife Service and Inland Fisheries Ireland.

The contents and objectives of the Shannon International River Basin Management Plan and the Shannon Catchment Flood Risk Management Plan for the Shannon IRBD should be considered during this phase.

A full work methodology should be developed prior to the commencement of any on site works.

The method proposed should include the following:

1. Works will only be initiated after the written approval of NPWS and Inland Fisheries Ireland has been received.

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2. The works will be undertaken outside of the main breeding season

3. No activity associated with the project will be undertaken during very wet weather, this is to minimise the loss of fine sands and sediments from the dredger to the surrounding marine environment.

4. The machinery will not be refuelled near the river and no fuels, oils etc. will be stored on-site.

5. Works will be monitored on a daily basis for the first three days by the site ecologist and weekly thereafter. All work for the following day/week will be agreed in advance between the contractor and site ecologist.

6. A weekly report of activities will be submitted to NPWS and the IFI.

7. All possible measures will be taken to minimise the release of fine sands and silts to the surrounding aquatic environment through appropriate codes of practise such as the ESPO, Environmental Codes of Practice www.espo.be

8. All works should cease to operate during periods of excessive rainfall in order to ensure suitable visibility for the MMO mitigations as outlined below together with ensuring sediment run-off is kept to a minimum.

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Detailed Mitigation Measures

- **Fisheries**: As per previous dumping at sea permits which SFPC have received it is on the basis that there will be no dumping or dredging carried out between March 1st and June 30th of each year. This is to ensure that the operation has no negative impact on the migration of fish species in the Shannon Estuary. This measure should again be imposed on the maintenance dredging application.

- **Cetaceans**: A condition of the dumping at sea act (1996) which the dump at sea permit is applied under, requires a marine mammal observer, with relevant expertise, to accompany the dredge/dump vessel to monitor and record activity of dolphins during the duration of the works to which the permit relates. As the Shannon estuary is a candidate Special Area of Conservation (SAC) for bottlenose dolphins *Tursiops truncatus,* it should be a condition of the permit that a buffer zone of 2.5km (approx. 1.4 nautical miles) shall be imposed around the dredge/dump vessel and all dredging/dumping will be suspended if dolphin activity occurs within this zone (for the duration that such activity occurs within this zone). All operations shall commence during suitable weather and visibility to ensure that this exclusion zone can be achieved. A suitable qualified MMO should be on site during the commencement of all operations with completed recording forms returned to NPWS within 4 weeks of completion of works.

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- **Benthic Fauna:** Potential effects will be mitigated by varying the location of the dumped material throughout the dump site, by having limitations on the volumes which can be dumped throughout the day. The dredging and dumping will be carried out under the restrictions and guidance set out in the dump at sea permit in order to minimise ecological impact.

- **Dredge spoil disposal:** Prior to the commencement of dredging, investigations into the slow release of the dredge spoil from the hooper allowing time for material to settle should be investigated in order to minimize any potential impacts to the marine environment and the integrity of the SAC/SPA.

- **Awareness of the Shannon Estuary Pollution Control Plan** http://www.seapt.ie/
  All contractors and operators working in the vicinity of Shannon Foynes Port Company and Limerick Dock should be made fully aware of the Shannon Pollution Control Plan prior to commencing any works on site. Its primary purpose is to set in motion the necessary actions to stop or minimise the discharge and to mitigate its effects. Effective planning ensures that the necessary actions are taken in a structured, logical and timely manner. This plan guides the Coordinator and On Scene Commander and other involved personnel through the decisions, which will be required in an incident response. The tables, figures and checklists provide a visible form of information, thus reducing the chance of oversight or error during the early stages of dealing with an emergency situation. For the plan to be effective, it must be:

  - familiar to those with key response functions in the ports
  - regularly exercised; and
  - reviewed and updated on a regular basis.

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5 CONCLUSIONS

ESPO checklist on good practise for balancing Natura 2000 with port and waterway development and operations (December 2009). (Source; EC Guidance on the implementation of the EU nature legislation in estuaries and coastal zones**)** [5]

Maintenance Dredging

Checklist Item	Action under SFPC Maintenance Dredging Application
A maintenance dredging strategy has been set up taking into account hydro-morphological and ecological aspects.	SFPC are currently in the process of signing up to ECOPORTS **www.ecoports.com** which will involve the development of an Environmental Management System (EMS) for both Limerick Dock and Foynes Port. It will also allow for the exchange of experiences and the implementation of good practise in respect of port-related environmental issues across Europe. By developing this EMS it also meets with recommendations outlined in the EC Guidance on the implementation of the EU nature legislation in estuaries and coastal zones
Based on latest information and a feedback-process involving all relevant stakeholders, dredging activities are – in compliance with economical and legal requirements – aiming to achieve the least impact on Natura 2000 conservation objectives possible.	By carrying out this Appropriate Assessment SFPC are aiming to achieve the least impact on Natura 2000 conservation objectives through the identification of all appropriate mitigation measures.
A sustainable maintenance dredging strategy or scheme is part of an integral management plan. Based on general principles in compliance with conservation objectives, dredging is flexible according to the requirements of a dynamic tidally influenced estuarine, river or coastal system.	SFPC will be bound by the conditions set upon them by the EPA in their dumping at sea permit. This will ensure a sustainable maintenance dredging strategy is adopted. The EPA will consult with all statutory parties including the NPWS and IFI prior to consent and therefore this will ensure the general principles are in compliance with conservation objectives.
Dredging activities have been optimized according to the following order: - Technical feasibility - Availability of dredgers - Safety, nautical requirements, navigability	SFPC will ensure dredging operations are optimized in line with the ESPO checklist provided here.

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[5] http://ec.europa.eu/environment/nature/natura2000/management/docs/guidance_doc.pdf

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- Legally binding ecological requirements (BHD, WFD etc.) - Administrative regulations (e.g. management plans, site specific objectives) - Full integration of long-term comprehensive hydro morphologic, sediment related and ecological criteria - Short-term and/or local criteria - Cost-effectiveness - Other non-binding aspects such as agreements with stakeholders	
Natura 2000 site management and maintenance measures	
The aim should be to meet feasible conservation objectives for sites in balance with long term ports and waterways development.	SFPC by undertaking this Habitats Directive Assessment aim to meet the conservation objectives of the sites in which their ports are located in order to work in harmony with the designations and their qualifying interest features
Port and waterways authorities should be actively involved in the setting up of management plans from the start.	SFPC are currently in the process of signing up to ECOPORTS **www.ecoports.com** which will involve the development of an Environmental Management System (EMS) for both Limerick Dock and Foynes Port. It will also allow for the exchange of experiences and the implementation of good practise in respect of port-related environmental issues across Europe. By developing this EMS it also meets with recommendations outlined in the EC Guidance on the implementation of the EU nature legislation in estuaries and coastal zones
In dealing with uncertainties (ecosystem knowledge, cause-effect relationships), research and monitoring schemes should be included as part of the management plan.	As part of this HDA key mitigation measures have been identified to ensure uncertainties in terms of impacts to qualifying interests are monitored during the course of the dredging operations.

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While the maintenance dredging works do have the potential to have significant negative effects on the integrity of the Lower River Shannon SAC and River Shannon and Fergus SPA following the implementation of the mitigation described in this Appropriate Assessment, it is expected that the proposed maintenance programme will avoid significant negative impacts to key sensitive receptors (Lamprey, Salmonids and Cetaceans) and other qualifying features of the SAC and SPA both along and in-combination with the other elements identified in this report. It is recommended that, following approval of this Appropriate Assessment, the mitigation measures detailed herein are developed further with National Parks and Wildlife Service and Inland Fisheries Ireland and that finalised

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measures are included in the contract documents for the proposed scheme. The contractors tendering for the proposed dredging works will be required to provide a detailed method statement on how the integrity of the SAC/SPA will be protected during the course of the works. This will be approved by the both National Parks and Wildlife Service (NPWS) and Inland Fisheries Ireland prior to any works taking place.

There should therefore be no requirement for Stage 3 (*Assessment of Alternative Solutions*) and 4 (*Assessment Where Adverse Impacts Remain*), of the appropriate assessment process.

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6 REFERENCES

Construction Industry Research and Information Association. Good practice guidelines on the control of water pollution from construction sites (C532)

Council Directive 79/409 EEC on the Conservation of Wild Birds

Council Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora

Department of the Environment, Heritage and Local Government (2009). Appropriate Assessment of Plans and Projects in Ireland, Guide for Planning Authorities, Dublin.

European Commission (2000a) Communication from the Commission on the Precautionary Principle, Office for Official Publications of the European Communities, Luxembourg.

European Commission (2000b) Managing Natura 2000 Sites: the provisions of Article 6 of the 'Habitats' Directive 92/43/EEC, Office for Official Publications of the European Communities, Luxembourg.

European Commission (2001) Assessment of Plans and Projects Significantly Affecting Natura 2000 Sites: Methodological guidance on the provisions of Article 6(3) and (4) of the Habitats Directive 92/43/EEC, Office for Official Publications of the European Communities, Luxembourg.

European Commission (2008) Guidance document on Article 6(4) of the 'Habitats Directive' 92/43/EEC – Clarification of the concepts of: alternative solutions, imperative reasons of overriding public interest, compensatory measures, overall coherence, opinion of the commission, Office for Official Publications of the European Communities, Luxembourg.

European Communities (Natural Habitats) Regulations (S.I. No. 94 of 1997)

Shannon International River Basin District Project (2008) Review of Best Practice Measures to Address Morphology Pressures, Limerick.

Guidance document on the implementation of the birds and habitats directive in estuaries and coastal zones with particular attention to port development and dredging.

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APPENDIX A

National Parks and Wildlife Service

Natura 2000 Site Synopsis

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SITE SYNOPSIS

SITE NAME: RIVER SHANNON AND RIVER FERGUS ESTUARIES SPA

SITE CODE: 004077

The estuaries of the River Shannon and River Fergus form the largest estuarine complex in Ireland. The site comprises all of the estuarine habitat west from Limerick City and south from Ennis, extending west as far as Killadysert and Foynes on the north and south shores respectively of the River Shannon (a distance of some 25 km from east to west). Also included are several areas in the outer Shannon estuary, notably Clonderalaw Bay and Poulnasherry Bay, as well as the intertidal areas on the south shore of the Shannon between Tarbert and Beal Point.

The site has vast expanses of intertidal flats. The main macro-invertebrate community present is a *Macoma-Scrobicularia-Nereis* community which provides a rich food resource for the wintering birds. Other species occurring include Common Cockle (*Cerastoderma edule*), Lugworm (*Arenicola marina*), the polychaete *Nepthys hombergii*, the gastropod *Hydrobia ulvae* and the crustacean *Corophium volutator*. Eelgrass (*Zostera* spp.) is present in places, along with green algae (e.g. *Ulva* spp. and *Enteromorpha* spp.). Salt marsh vegetation frequently fringes the mudflats and this provides important high tide roost areas for the wintering birds. Characteristic species occurring include Common Saltmarsh-grass (*Puccinellia maritima*), Sea Aster (*Aster tripolium*), Thrift (*Armeria maritima*), Sea-milkwort (*Glaux maritima*), Sea Plantain (*Plantago maritima*), Red Fescue (*Festuca rubra*) and Saltmarsh Rush (*Juncus gerardi*). In the innermost parts of the estuaries, the tidal channels or creeks are fringed with species such as Common Reed (*Phragmites australis*) and club-rushes (*Scirpus maritimus, S. lacustris* subsp. *tabernaemontani)*. Also found is the nationally rare Triangular Club-rush (*Scirpus triqueter*). Elsewhere in the site the shoreline comprises stony or shingle beaches.

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The site is the most important coastal wetland site in the country and regularly supports in excess of 50,000 wintering waterfowl (mean of 59,183 for the 4 seasons 1996-97 to 1999/00), a concentration easily of international importance. The site has internationally important populations of Dunlin (14,987), Black-tailed Godwit (706) and Redshank (1,983) - all figures are average peaks for 3 of the 5 seasons in the 1995/96-1999/00 period. A further 16 species have populations of national importance, i.e. Cormorant (148), Whooper Swan (141), Greylag Goose (88), Shelduck (895), Wigeon (3,025), Teal (1,558), Pintail (40), Shoveler (56), Scaup (76), Golden Plover (4,073), Grey Plover (564), Lapwing (13,007), Knot (686), Bar-tailed Godwit (481), Curlew (1,231) and Greenshank (33). The site is among the most important in the country for several of these species, notably Dunlin (11% of national total), Grey Plover (7.5% of total), Lapwing (6.5% of total), Redshank (6% of total) and Shelduck (6.0% of total). The site is also used by Oystercatcher (363), Ringed Plover (70), Brent Goose (135), Great Crested Grebe (47), Red-breasted Merganser (14), Mallard (247), Turnstone (71), Mute Swan (54), Grey Heron (25), Black-headed Gull (1,233) and Common Gull (194).

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The Shannon / Fergus system was formerly frequented by a Greenland White-fronted Goose population but this declined during the 1980s and 1990s and the birds now appear appear to have abandoned the area. The site provides both feeding and roosting areas for the wintering birds. Habitat quality for most of the estuarine habitats is good. Some species, particularly Whooper Swan and Greylag Goose, utilise areas outside of the site for feeding.

Apart from the wintering birds, large numbers of some species also pass through the site whilst on migration in spring and/or autumn. Regular species include Black-tailed Godwit, Whimbrel and Greenshank.

Much of the land adjacent to the rivers and estuaries has been reclaimed and improved for agriculture and is protected by embankments (especially along the River Fergus estuary). Further reclamation, especially near to the urbanised and industrial areas continues to pose a threat. The site receives pollution from several sources, including industry and agriculture, but it is not known if this has any significant impacts on the wintering birds. Aquaculture occurs in some areas of the site – future increases in this activity could cause disturbance to the habitats and the associated birds. Common Cord-grass (*Spartina anglica*) is well-established and may threaten some of the estuarine habitats. Some disturbance occurs from boating activities.

This site is of great ornithological interest, being of international importance on account of the numbers of wintering birds it supports. It also supports internationally important numbers of three species, i.e. Dunlin, Black-tailed Godwit and Redshank. In addition, there are 16 species that have populations of national importance. For several of the bird species, it is the top site in the country. Also of note is that three of the species which occur regularly are listed on Annex I of the E.U. Birds Directive, i.e. Whooper Swan, Golden Plover and Bar-tailed Godwit. The site is most effectively censused from the air and this is carried out in most winters.

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SITE SYNOPSIS

SITE NAME : LOWER RIVER SHANNON

SITE CODE : 002165

This very large site stretches along the Shannon valley from Killaloe to Loop Head/ Kerry Head, a distance of some 120 km. The site thus encompasses the Shannon, Feale, Mulkear and Fergus Estuaries, the freshwater lower reaches of the River Shannon (between Killaloe and Limerick), the freshwater stretches of much of the Feale and Mulkear catchments and the marine area between Loop Head and Kerry Head. The Shannon and Fergus flow through Carboniferous limestone as far as Foynes, but west of Foynes Namurian shales and flagstones predominate (except at Kerry Head, which is formed from Old Red Sandstone). The eastern sections of the Feale catchment flow through Namurian Rocks and the western stretches through Carboniferous Limestone. The Mulkear flows through Lower Palaeozoic Rocks in the upper reaches before passing through Namurian Rocks, followed by Lower Carboniferous Shales and Carboniferous Limestone. The Mulkear River itself, immediately north of Pallas Green, passes through an area of Rhyolites, Tuffs and Agglomerates. Rivers within the sub-catchment of the Feale include the Galey, Smearlagh, Oolagh, Allaughaun, Owveg, Clydagh, Caher, Breanagh and Glenacarney. Rivers within the sub-catchment of the Mulkear include the Killeenagarriff, Annagh, Newport, the Dead River, the Bilboa, Glashacloonaraveela, Gortnageragh and Cahernahallia.

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The site is a candidate SAC selected for lagoons and alluvial wet woodlands, both habitats listed on Annex I of the E.U. Habitats Directive. The site is also selected for floating river vegetation, *Molinia* meadows, estuaries, tidal mudflats, Atlantic salt meadows, Mediterranean salt meadows, *Salicornia* mudflats, sand banks, perennial vegetation of stony banks, sea cliffs, reefs and large shallow inlets and bays all habitats listed on Annex I of the E.U. Habitats Directive. The site is also selected for the following species listed on Annex II of the same directive – Bottle-nosed Dolphin, Sea Lamprey, River Lamprey, Brook Lamprey, Freshwater Pearl Mussel, Atlantic Salmon and Otter.

The Shannon and Fergus Estuaries form the largest estuarine complex in Ireland. They form a unit stretching from the upper tidal limits of the Shannon and Fergus Rivers to the mouth of the Shannon estuary (considered to be a line across the narrow strait between Kilcredaun Point and Kilconly Point). Within this main unit there are several tributaries with their own 'sub-estuaries' e.g. the Deel River, Mulkear River, and Maigue River. To the west of Foynes, a number of small estuaries form indentations in the predominantly hard coastline, namely Poulnasherry Bay, Ballylongford Bay, Clonderalaw Bay and the Feale or Cashen River Estuary.

Both the Fergus and inner Shannon estuaries feature vast expanses of intertidal mudflats, often fringed with saltmarsh vegetation. The smaller estuaries also feature mudflats, but have their own unique characteristics, e.g. Poulnasherry Bay is stony and unusually rich in species and biotopes. Plant species are typically scarce on the mudflats, although there are some Eel-grass beds (*Zostera* spp.) and patches of green

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algae (e.g. *Ulva* sp. and *Enteromorpha* sp.). The main macro-invertebrate community, which has been noted from the inner Shannon and Fergus estuaries, is a *Macoma-Scrobicularia-Nereis* community.

In the transition zone between mudflats and saltmarsh, specialised colonisers of mud predominate: swards of Common Cord-grass (*Spartina anglica*) frequently occur in the upper parts of the estuaries. Less common are swards of Glasswort (*Salicornia europaea* agg.). In the innermost parts of the estuaries, the tidal channels or creeks are fringed with species such as Common Reed (*Phragmites australis*) and Club-rushes (*Scirpus maritimus, S. tabernaemontani* and *S. triquetrus*). In addition to the nationally rare Triangular Club-rush (*Scirpus triquetrus*), two scarce species are found in some of these creeks (e.g. Ballinacurra Creek): Lesser Bulrush (*Typha angustifolia*) and Summer Snowflake (*Leucojum aestivum*).

Saltmarsh vegetation frequently fringes the mudflats. Over twenty areas of estuarine saltmarsh have been identified within the site, the most important of which are around the Fergus Estuary and at Ringmoylan Quay. The dominant type of saltmarsh present is Atlantic salt meadow occurring over mud. Characteristic species occurring include Common Saltmarsh Grass (*Puccinellia maritima*), Sea Aster (*Aster tripolium*), Thrift (*Armeria maritima*), Sea-milkwort (*Glaux maritima*), Sea Plantain (*Plantago maritima*), Red Fescue (*Festuca rubra*), Creeping Bent (*Agrostis stolonifera*), Saltmarsh Rush (*Juncus gerardi*), Long-bracted Sedge (*Carex extensa*), Lesser Sea-spurrey (*Spergularia marina*) and Sea Arrowgrass (*Triglochin maritima*). Areas of Mediterranean salt meadows, characterised by clumps of Sea Rush (*Juncus maritimus*) occur occasionally. Two scarce species are found on saltmarshes in the vicinity of the Fergus Estuary: a type of robust Saltmarsh-grass (*Puccinellia foucaudii*), sometimes placed within the compass of Common Saltmarsh-grass (*Puccinellia maritima*) and Hard-grass (*Parapholis strigosa*).

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Saltmarsh vegetation also occurs around a number of lagoons within the site. The two which have been surveyed as part of a National Inventory of Lagoons are Shannon Airport Lagoon and Cloonconeen Pool. Cloonconeen Pool (4-5 ha) is a natural sedimentary lagoon impounded by a low cobble barrier. Seawater enters by percolation through the barrier and by overwash. This lagoon represents a type which may be unique to Ireland since the substrate is composed almost entirely of peat. The adjacent shore features one of the best examples of a drowned forest in Ireland. Aquatic vegetation in the lagoon includes typical species such as Beaked Tasselweed (*Ruppia maritima*) and green algae (*Cladophora* sp.). The fauna is not diverse, but is typical of a high salinity lagoon and includes six lagoon specialists (*Hydrobia ventrosa, Cerastoderma glaucum, Lekanesphaera hookeri, Palaemonetes varians, Sigara stagnalis* and *Enochrus bicolor*). In contrast, Shannon Airport Lagoon (2 ha) is an artificial saline lake with an artificial barrier and sluiced outlet. However, it supports two Red Data Book species of Stonewort (*Chara canescens* and *Chara cf. connivens*).

Most of the site west of Kilcredaun Point/Kilconly Point is bounded by high rocky sea cliffs. The cliffs in the outer part of the site are sparsely vegetated with lichens, Red Fescue, Sea Beet (*Beta vulgaris*), Sea Campion (*Silene maritima*), Thrift and Plantains (*Plantago* spp.). A rare endemic Sea Lavender (*Limonium recurvum* subsp.

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pseudotranswallinum) occurs on cliffs near Loop Head. Cliff-top vegetation usually consists of either grassland or maritime heath. The boulder clay cliffs further up the estuary tend to be more densely vegetated, with swards of Red Fescue and species such as Kidney Vetch (*Anthyllis vulneraria*) and Bird's-foot Trefoil (*Lotus corniculatus*).

The site supports an excellent example of a large shallow inlet and bay. Littoral sediment communities in the mouth of the Shannon Estuary occur in areas that are exposed to wave action and also in areas extremely sheltered from wave action. Characteristically, exposed sediment communities are composed of coarse sand and have a sparse fauna. Species richness increases as conditions become more sheltered. All shores in the site have a zone of sand hoppers at the top and below this each of the shores has different characteristic species giving a range of different shore types in the pcSAC.

The intertidal reefs in the Shannon Estuary are exposed or moderately exposed to wave action and subject to moderate tidal streams. Known sites are steeply sloping and show a good zonation down the shore. Well developed lichen zones and littoral reef communities offering a high species richness in the sublittoral fringe and strong populations of *Paracentrotus lividus* are found. The communities found are tolerant to sand scour and tidal streams. The infralittoral reefs range from sloping platforms with some vertical steps to ridged bedrock with gullies of sand between the ridges to ridged bedrock with boulders or a mixture of cobbles, gravel and sand. Kelp is very common to about 18m. Below this it becomes rare and the community is characterised by coralline crusts and red foliose algae.

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Other coastal habitats that occur within the site include the following:

- stony beaches and bedrock shores - these shores support a typical zonation of seaweeds (*Fucus* spp., *Ascophyllum nodosum* and kelps).
- shingle beaches - the more stable areas of shingle support characteristic species such as Sea Beet, Sea Mayweed (*Matricaria maritima*), Sea Campion and Curled Dock (*Rumex crispus*).
- Sandbanks which are slightly covered by sea water at all times – there is a known occurrence of sand/gravel beds in the area from Kerry Head to Beal Head.
- sand dunes - a small area of sand dunes occurs at Beal Point. The dominant species is Marram Grass (*Ammophila arenaria*).

Flowing into the estuaries are a number of tidal rivers.

Freshwater rivers have been included in the site, most notably the Feale and Mulkear catchments, the Shannon from Killaloe to Limerick (along with some of its tributaries, including a short stretch of the Kilmastulla River), the Fergus up as far as Ennis, and the Cloon River. These systems are very different in character: the Shannon being broad, generally slow-flowing and naturally eutrophic; the Fergus being smaller and alkaline; while the narrow, fast-flowing Cloon is acid in nature. The Feale and Mulkear catchments exhibit all the aspects of a river from source to mouth. Semi-natural habitats, such as wet grassland, wet woodland and marsh occur by the rivers, however, improved grassland is most common. One grassland type of particular

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conservation significance, *Molinia* meadows, occurs in several parts of the site and the examples at Worldsend on the River Shannon are especially noteworthy. Here are found areas of wet meadow dominated by rushes and sedges and supporting a diverse and species-rich vegetation, including such uncommon species as Blue-eyed Grass (*Sisyrinchium bermudiana*) and Pale Sedge (*Carex pallescens*).

Floating river vegetation characterised by species of Water-crowfoot (*Ranunculus* spp.), Pondweeds (*Potamogeton* spp.) and the moss *Fontinalius antipyretica* are present throughout the major river systems within the site. The rivers contain an interesting bryoflora with *Schistidium alpicola* var. *alpicola* recorded from in-stream boulders on the Bilboa, new to county Limerick.

Alluvial woodland occurs on the banks of the Shannon and on islands in the vicinity of the University of Limerick. The woodland is up to 50m wide on the banks and somewhat wider on the largest island. The most prominent woodland type is gallery woodland where White Willow (*Salix alba*) dominates the tree layer with occasional Alder (*Alnus glutinosa*). The shrub layer consists of various willow species with sally (*Salix cinerea* ssp. *oleifolia*) and what appear to be hybrids of *S. alba* x *S. viminalis.* The herbaceous layer consists of tall perennial herbs. A fringe of Bulrush (*Typha* sp.) occurs on the riverside of the woodland. On slightly higher ground above the wet woodland and on the raised embankment remnants of mixed oak-ash-alder woodland occur. These are poorly developed and contain numerous exotic species but locally there are signs that it is invading open grassland. Alder is the principal tree species with occasional Oak (*Quercus robur*), Elm (*Ulmus glabra, U. procera*), Hazel (*Corylus avellana*), Hawthorn (*Crataegus monogyna*) and the shrubs Guelder-rose (*Viburnum opulus*) and willows. The ground flora is species-rich.

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Woodland is infrequent within the site, however Cahiracon Wood contains a strip of old Oak woodland. Sessile Oak (*Quercus petraea*) forms the canopy, with an understorey of Hazel and Holly (*Ilex aquifolium*). Great Wood-rush (*Luzula sylvatica*) dominates the ground flora. Less common species present include Great Horsetail (*Equisetum telmeteia*) and Pendulous Sedge (*Carex pendula*).

In the low hills to the south of the Slievefelim mountains, the Cahernahallia River cuts a valley through the Upper Silurian rocks. For approximately 2km south of Cappagh Bridge at Knockanavar, the valley sides are wooded. The woodland consists of Birch (*Betula* spp.), Hazel, Oak, Rowan (*Sorbus aucuparia*), some Ash (*Fraxinus excelsior*) and Willow (*Salix* spp.). Most of the valley is not grazed by stock, and as a result the trees are regenerating well. The ground flora feature prominent Greater wood-rush and Bilberry (*Vaccinium myrtillus*) with a typical range of woodland herbs. Where there is more light available, Bracken (*Pteridium aquilinum*) features.

The valley sides of the Bilboa and Gortnageragh Rivers, on higher ground north east of Cappamore, support patches of semi-natural broadleaf woodland dominated by Ash, Hazel, Oak and Birch. There is a good scrub layer with Hawthorn, Willow, Holly and Blackthorn (*Prunus spinosa*) common. The herb layer in these woodlands is often open with a typically rich mixture of woodland herbs and ferns. Moss species diversity is high. The woodlands are ungrazed. The hazel is actively coppiced in places.

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There is a small area of actively regenerating cut away raised bog at Ballyrorheen. It is situated approx. 5km north west of Cappamore Co. Limerick. The bog contains some wet areas with good moss (*Sphagnum*) cover. Species of particular interest include the Cranberry (*Vaccinium oxycoccos*) and the White Sedge (*Carex curta*) along with two other regionally rare mosses including *S. fimbriatum*. The site is being invaded by Birch (*Betula pubescens*) scrub woodland. Both commercial forestry and the spread of rhododendron has greatly reduced the overall value of the site.

A number of plant species that are Irish Red Data Book species occur within the site - several are protected under the Flora (Protection) Order, 1999:

- Triangular Club-rush (*Scirpus triquetrus*) - in Ireland this protected species is only found in the Shannon Estuary, where it borders creeks in the inner estuary.
- Opposite-leaved Pondweed (*Groenlandia densa*) - this protected pondweed is found in the Shannon where it passes through Limerick City.
- Meadow Barley (*Hordeum secalinum*) - this protected species is abundant in saltmarshes at Ringmoylan and Mantlehill.
- Hairy Violet (*Viola hirta*) - this protected violet occurs in the Askeaton/Foynes area.
- Golden Dock (*Rumex maritimus*) - noted as occurring in the River Fergus Estuary.
- Bearded Stonewort (*Chara canescens*) - a brackish water specialist found in Shannon Airport lagoon.
- Convergent Stonewort (*Chara connivens*) - presence in Shannon Airport Lagoon to be confirmed.

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Overall, the Shannon and Fergus Estuaries support the largest numbers of wintering waterfowl in Ireland. The highest count in 1995-96 was 51,423 while in 1994-95 it was 62,701. Species listed on Annex I of the E.U. Birds Directive which contributed to these totals include: Great Northern Diver (3; 1994/95), Whooper Swan (201; 1995/96), Pale-bellied Brent Goose (246; 1995/96), Golden Plover (11,067; 1994/95) and Bar-tailed Godwit (476; 1995/96). In the past, three separate flocks of Greenland White-fronted Goose were regularly found but none were seen in 1993/94.

Other wintering waders and wildfowl present include Greylag Goose (216; 1995/96), Shelduck (1,060; 1995/96), Wigeon (5,976; 1995/96); Teal (2,319; 1995-96); Mallard (528; 1995/96), Pintail (45; 1995/96), Shoveler (84; 1995/96), Tufted Duck (272; 1995/96), Scaup (121; 1995/96), Ringed Plover (240; 1995/96), Grey Plover (750; 1995/96), Lapwing (24,581; 1995/96), Knot (800; 1995/96), Dunlin (20,100; 1995/96), Snipe (719, 1995/96), Black-tailed Godwit (1062; 1995/96), Curlew (1504; 1995/96), Redshank (3228; 1995/96), Greenshank (36; 1995/96) and Turnstone (107; 1995/96). A number of wintering gulls are also present, including Black-headed Gull (2,216; 1995/96), Common Gull (366; 1995/96) and Lesser Black-backed Gull (100; 1994/95). This is the most important coastal site in Ireland for a number of the waders including Lapwing, Dunlin, Snipe and Redshank. It also provides an important staging ground for species such as Black-tailed Godwit and Greenshank.

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A number of species listed on Annex I of the E.U. Birds Directive breed within the site. These include Peregine Falcon (2-3 pairs), Sandwich Tern (34 pairs on Rat Island, 1995), Common Tern (15 pairs: 2 on Sturamus Island and 13 on Rat Island, 1995), Chough (14-41 pairs, 1992) and Kingfisher. Other breeding birds of note include Kittiwake (690 pairs at Loop Head, 1987) and Guillemot (4010 individuals at Loop Head, 1987)

There is a resident population of Bottle-nosed Dolphin in the Shannon Estuary consisting of at least 56-68 animals (1996). This is the only known resident population of this E.U. Habitats Directive Annex II species in Ireland. Otter, a species also listed on Annex II of this directive, is commonly found on the site.

Five species of fish listed on Annex II of the E.U. Habitats Directive are found within the site. These are Sea Lamprey (*Petromyzon marinus*), Brook Lamprey (*Lampetra planeri*), River Lamprey (*Lampetra fluviatilis*), Twaite Shad (*Allosa fallax fallax*) and Salmon (*Salmo salar*). The three lampreys and Salmon have all been observed spawning in the lower Shannon or its tributaries. The Fergus is important in its lower reaches for spring salmon while the Mulkear catchment excels as a grilse fishery though spring fish are caught on the actual Mulkear River. The Feale is important for both types. Twaite Shad is not thought to spawn within the site. There are few other river systems in Ireland which contain all three species of Lamprey.

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Two additional fish of note, listed in the Irish Red Data Book, also occur, namely Smelt (*Osmerus eperlanus*) and Pollan (*Coregonus autumnalis pollan*). Only the former has been observed spawning in the Shannon.

Freshwater Pearl-mussel (*Margaritifera margaritifera*), a species listed on Annex II of the E.U. Habitats Directive, occurs abundantly in parts of the Cloon River.

There is a wide range of landuses within the site. The most common use of the terrestrial parts is grazing by cattle and some areas have been damaged through over-grazing and poaching. Much of the land adjacent to the rivers and estuaries has been improved or reclaimed and is protected by embankments (especially along the Fergus Estuary). Further, reclamation continues to pose a threat as do flood relief works (e.g. dredging of rivers). Gravel extraction poses a major threat on the Feale.

In the past, Cord-grass (*Spartina* sp.) was planted to assist in land reclamation. This has spread widely, and may oust less vigorous colonisers of mud and may also reduce the area of mudflat available to feeding birds.

Domestic and industrial wastes are discharged into the Shannon, but water quality is generally satisfactory - except in the upper estuary, reflecting the sewage load from Limerick City. Analyses for trace metals suggest a relatively clean estuary with no influences by industrial discharges apparent. Further industrial development along the Shannon and water polluting operations are potential threats.

Fishing is a main tourist attraction on the Shannon and there are a large number of Angler Associations, some with a number of beats. Fishing stands and styles have been erected in places. The River Feale is a designated Salmonid Water under the

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E.U. Freshwater Fish Directive. Other uses of the site include commercial angling, oyster farming, boating (including dolphin-watching trips) and shooting. Some of these may pose threats to the birds and dolphins through disturbance. Specific threats to the dolphins include underwater acoustic disturbance, entanglement in fishing gear and collisions with fast moving craft.

This site is of great ecological interest as it contains a high number of habitats and species listed on Annexes I and II of the E.U. Habitats Directive, including the priority habitat lagoon, the only known resident population of Bottle-nosed Dolphin in Ireland and all three Irish lamprey species. A good number of Red Data Book species are also present, perhaps most notably the thriving populations of Triangular Club-rush. A number of species listed on Annex I of the E.U. Birds Directive are also present, either wintering or breeding. Indeed, the Shannon and Fergus Estuaries form the largest estuarine complex in Ireland and support more wintering wildfowl and waders than any other site in the country. Most of the estuarine part of the site has been designated a Special Protection Area (SPA), under the E.U. Birds Directive, primarily to protect the large numbers of migratory birds present in winter.

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Proposed Special Conservation Interests for River Shannon and River Fergus Estuaries SPA (4077)

Site is selected for:
Cormorant
Light-bellied Brent Goose
Shelduck
Wigeon
Teal
Ringed Plover
Golden Plover
Grey Plover
Lapwing
Knot
Dunlin
Black-tailed Godwit
Bar-tailed Godwit
Curlew
Redshank
Greenshank
20,000 wintering waterbirds

Additional Special Conservation Interests:
Whooper Swan
Pintail
Shoveler
Scaup
Black-headed Gull
Wetland & Waterbirds

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Main conservation objective:
To maintain the special conservation interests for this SPA at favourable conservation status: Cormorant; Light-bellied Brent Goose, Shelduck, Wigeon, Teal, Ringed Plover, Golden Plover, Grey Plover, Lapwing, Knot, Dunlin, Black-tailed Godwit, Bar-tailed Godwit, Curlew, Redshank, Greenshank, 20,000 wintering waterbirds, Whooper Swan, Pintail, Shoveler, Scaup, Black-headed Gull, Wetland & Waterbirds.

The favourable conservation status of a species is achieved when:

- population data on the species concerned indicate that it is maintaining itself, and
- the natural range of the species is neither being reduced or likely to be reduced for the foreseeable future, and
- there is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis.

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Draft (Generic) Conservation Objectives – Lower River Shannon cSAC (site code 002165)

European and national legislation places a collective obligation on Ireland and its citizens to maintain at favourable conservation status areas designated as candidate Special Areas of Conservation. The Government and its agencies are responsible for the implementation and enforcement of regulations that will ensure the ecological integrity of these sites.

According to the EU Habitats Directive, favourable conservation status of a habitat is achieved when:

- its natural range, and area it covers within that range, is stable or increasing, and
- the ecological factors that are necessary for its long-term maintenance exist and are likely to continue to exist for the foreseeable future, and
- the conservation status of its typical species is favourable as defined below.

The favourable conservation status of a species is achieved when:

- population data on the species concerned indicate that it is maintaining itself, and
- the natural range of the species is neither being reduced or likely to be reduced for the foreseeable future, and
- there is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis.

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Objective 1: To maintain the Annex I habitats for which the cSAC has been selected at favourable conservation status: Large shallow inlets and bays; Estuaries; *Salicornia* and other annuals colonising mud and sand; Vegetated sea cliffs of the Atlantic and Baltic coasts; Mediterranean salt meadows (Juncetalia maritimi); Coastal lagoons; Mudflats and sandflats not covered by seawater at low tide; Atlantic salt meadows (Glauco-Puccinellietalia maritimae); Sandbanks which are slightly covered by sea water all the time; Reefs; Perennial vegetation of stony banks; Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation; *Molinia* meadows on calcareous, peaty or clayey-silt-laden soils (Molinion caeruleae); Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (Alno-Padion, Alnion incanae, Salicion albae)

Objective 2: To maintain the Annex II species for which the cSAC has been selected at favourable conservation status: *Lampetra fluviatilis*, *Lampetra planeri*, *Petromyzon marinus*, *Salmo salar*, *Margaritifera margaritifera*, *Tursiops truncatus*, *Lutra lutra*

Objective 3: To maintain the extent, species richness and biodiversity of the entire site

Objective 4: To establish effective liaison and co-operation with landowners, legal users and relevant authorities.

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Draft Conservation Objectives – Lagoons

Objective: To maintain the favourable conservation condition of Lagoons in Lower River Shannon cSAC (site code 002165), which is defined by the following list of attributes and targets:

Attribute	Target
Area	
Habitat area	Maintain or increase area, subject to natural variation

Structure and function	
Salinity regime	Maintain within natural range
Water depth	Maintain within natural range
Hydrological regime	Maintain within natural range
Barrier	Maintain permeability
Water quality - Chlorophyll A - chemical parameters	
Maximum depth of macrophytes	
Typical plant species	Maintain number and extent of listed lagoonal specialists, subject to natural variation
Typical invertebrate species	Maintain listed lagoon specialists, subject to natural variation

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APPENDIX B

Heavily Modified Waterbody Information

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Sector: **Ports and Harbours**

Waterbody Information:

Waterbody Name	Limerick Dock		Easting	Northing
Waterbody ID	SH_060_0900	Upstream limit	158,799	159,027
Waterbody Type	TW2 Meso/Polyhaline, Strongly mesotidal, Sheltered.	Downstream limit	152,960	156,000

List the pressures identifed within the HMWB/AWB designation for this waterbody	Presence & scale of Limerick Dock and it's associated shipping and
Record other water uses appearing to cause signficant pressure not identified within the HMWB/AWB designation	

	A		B			C	D	E	F	G	H	I
Pressure (physical modification)	**Is the pressure present? (Y/N) If Yes, proceed to column B.**	**Potential Impacts**	**Is there a significant adverse ecological impact or, in the absence of any mitigation already in place, could there be a significant adverse impact? (Y/N) If yes, proceed to column C, if no document and proceed to Column G.**	**Mitigation Measures**	**No.**	**Is the measure practicable given the characteristics of the water body? (Yes/No) If yes, proceed to Column D. If no, document and proceed to column G.**	**Is the mitigation measure in place and adequate? (Yes/No) If No, proceed to Column E. If Yes document the mitigation measure and proceed to Column G.**	**Can the measure be implemented without having a significant adverse impact on use? (Yes/No) If yes, proceed to column F, if no document and proceed to Column G.**	**Can the measure be implemented without having a significant adverse impact on the wider environment? (Yes/No) If yes, proceed to Column G, If no document and proceed to Column G.**	**Document: x : For measures not in place (proceed to Column H) ✓: For those already in place and adequate - : For those screened out**	**Will the mitigation measure provide more than a slight ecological benefit when considered alone or in combination with other measures? If yes, proceed to Column I; if no, document**	**Document any reasons which could affect the inclusion of the measure in the RBMP (e.g. prioritisation in combination with other measures, disproportionate cost, other reasons why an extended deadline or less stringent target might be justified)**
Maintenance Dredging	Y	Physical disturbance due to removal of sediment or re-deposition of disturbed sediment; Increased suspended sediment in water column; change in flows; change in wave propagation; change in sediment transport; direct or indirect habitat loss or change; red	Y **(Ref: expert judgement resons for identification as pHMWB in Article 5 Report)**	Reduce the need to dredge (e.g. Minimise under-keel clearance; fluid mud navigation; flow manipulation or training works)	1	Y	Y	-	-	-		
				Prepare a disposal strategy (e.g. Consider frequency and quantity of dredging; phasing; forward planning)	2	Y	Yes. Limerick Dock has a five year dredge permit in place which is due for renewal in 2009	Yes	Yes	√	Yes	As the dredge plan is due for renewal in 2009 the ecological requirements of this HMWB can be taken into consideration at this stage in order to allow it to meet it's WFD requirements
				Reduce impact of dredging (e.g. Dredge smaller area, shallower depth; dredger type)	3	Y	Yes. Dredging is restricted within the Port between Feb and June.Dredging is also kept to a strict minimum given the high cost to the port. The methodology used is trailer suction which can have controls applied to minimise re-suspension	Yes	Yes	√	Yes	Trailer suction dredging is currently used within Limerick Dock bucket dredging is no longer carried out. No overspill is allowed and Best Practise from European Seaport is adopted. Limerick Dock uses it's own boat and operators.
				Reduce sediment resuspension (e.g. Minimise bucket release; use visor; silt curtains; manage overspill)	4	Yes	Yes	Yes	Yes	√	Yes	The current trailer suction dredger operates using a head which causes minimal agitation. The Suction head is kept as close as possible to the mud in order to maximise the operation this leaves no room for re-suspension.
				Alter timing of disposal (e.g. Seasonal or tidal restrictions)	5	Yes	Yes. As dredging is restricted in the months from Feb- June this also implies dumping is restricted within these months.There are also tidal restrictions as high tide is the optimium for access to the dump sites.	Yes	Yes		Yes	
				Sediment management (e.g. Trickle recharge, sediment bypass; water column recharge; beneficial replacement)	6	Yes	Yes	Yes	Yes	√	Yes	When applying for their permits research was carried out as to whether there was a possible re-use of the material from Local Authorities etc. The material is largely made up of fine silt and therefore was deemed un-suitable.
				Indirect or offsite mitigation	7	No other use of material for enhancement, no waves in area	-	-	-	-	-	-
Dredged material disposal	Yes	Smothering due to deposition of sediment; disturbance due to deposition of resuspended sediment; increased suspended sediment in water column; direct habitat loss or change due to disposal.		Site selection (e.g. Avoid sensitive sites)	8	Yes - As part of the Dump at Sea permit the application is approved by the MLVC. Members from NPWS & MI sit on this board whom approved the dump site selection keeping in mind it's designation as an SPA/SAC.	Yes	Yes	Yes	√	Yes	
				Manage disturbance (e.g. Confine disturbance; dispose over wider area; disposal method or rate)	9	Yes	Yes	Yes	Yes	√	Yes	When next applying for their permit in 2009 Limerick Dock can investigate the disposal method and look at a slow release from the hooper allowing time for material to settle.
				Prepare a disposal strategy (e.g. Consider frequency and quantity of dredging; phasing; forward planning)	*2*	Yes	Yes	Yes	Yes	√	Yes	
				Alter timing of disposal (e.g. Seasonal or tidal restrictions)	*5*	Yes. Restricted by dredging between the months of Feb-June	Yes	Yes	Yes	√	Yes	
				Indirect or offsite mitigation	*7*	-	-	-	-	-	-	-
Vessel Movement	Y	Physical disturbance of sea bed habitats; ship wash (leading to erosion); indirect impacts and habitats.	Yes	Modify channel (e.g. Deepen; realign channel)	10	Y	Y	-	-	-		
				Modify vessel design (e.g. Shallower draft)	11	Y	N	N	-	-		
				Vessel Management (e.g. Traffic management; speed limits)	12	Yes. All ship traffic is accepted to Limerick with strict underkeel clearance enforcement. Dry bulk ships 50cms UKC and bulk liquids 60cms UKC. Ships are conducted by licensed pilots and with permission of the harbour master	Yes. Speeds are controlled at all times so as to be consistent with safety and the prevailing weather and tidal conditions.	Yes	Yes	√		
				Indirect or offsite mitigation	*7*	-	-	-	-	-	-	-
Existing modifications, including structures, reclamation and capital dredging	Y	Change in flows; changes in sediment transport; change in wave energy or direction; change in water quality resulting from changes in flows; direct or indirect habitat loss; disruption of habitat continuity or connectivity.	No - No permanent structures in place to interfere with water flow other than dock structure and bridges	Remove obsolete structure	13	-	-	-	-	-	-	-
				Modify structure or reclamation (e.g. Construct culverts in breakwaters; reduce wave reflection; increase wave absorption; replace with environmentally friendly materials or design; compensatory dredging)	14	-	-	-	-	-	-	-
				Flow manipulation (e.g. Construct structures to normalise flow; realign frontage)	15	-	-	-	-	-	-	-
				Sediment management (e.g. Trickle recharge, sediment bypass; water column recharge; beneficial replacement)	*6*	-	-	-	-	-	-	-
				Indirect or offsite mitigation	*7*	-	-	-	-	-	-	-

*Italics denote measures that are applicable to more than one impact.It may not be necessary to re-assess the measure, please see Guidance.

Limerick Dock is opting in to the ESPO - Ecoports Environmental Sharing Experience. This will lead to the development of an Environmental Management Plan for Limerick Dock which they will implement.

Hydromorphological assessment for classification	Good Ecological Potential or Better
CFB Fish Status	Moderate
EPA Overall Draft Status	Moderate

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Sector: **Ports and Harbours**

Waterbody Information:

			Easting	Northing
Waterbody Name	Foynes Harbour			
Waterbody ID	SH_060_0350	Upstream limit	125,470	152,100
Waterbody Type	TW2 Meso/Polyhaline, Strongly mesotdal, Sheltered.	Downstream limit	123,910	152,470

List the pressures identifed within the HMWB/AWB designation for this waterbody	Presence and scale of the port operations
Record other water uses appearing to cause signficant pressure not identified within the HMWB/AWB designation	

	A		B			C	D	E	F	G	H	I
Pressure (physical modification)	**Is the pressure present? (Y/N) If Yes, proceed to column B.**	**Potential Impacts**	**Is there a significant adverse ecological impact or, in the absence of any mitigation already in place, could there be a significant adverse impact? (Y/N) If yes, proceed to column C, if no document and proceed to Column G.**	**Mitigation Measures**	**No.**	**Is the measure practicable given the characteristics of the water body? (Yes/No) If yes, proceed to Column D. If no, document and proceed to column G.**	**Is the mitigation measure in place and adequate? (Yes/No) If No, proceed to Column E. If Yes document the mitigation measure and proceed to Column G.**	**Can the measure be implemented without having a significant adverse impact on use? (Yes/No) If yes, proceed to column F, if no document and proceed to Column G.**	**Can the measure be implemented without having a significant adverse impact on the wider environment? (Yes/No) If yes, proceed to Column G, If no document and proceed to Column G.**	**Document: x : For measures not in place (proceed to Column H) ✔: For those already in place and adequate - : For those screened out**	**Will the mitigation measure provide more than a slight ecological benefit when considered alone or in combination with other measures? If yes, proceed to Column I; if no, document**	**Document any reasons which could affect the inclusion of the measure in the RBMP (e.g. prioritisation in combination with other measures, disproportionate cost, other reasons why an extended deadline or less stringent target might be justified)**
Maintenance Dredging	Y	Physical disturbance due to removal of sediment or re-deposition of disturbed sediment; Increased suspended sediment in water column; change in flows; change in wave propagation; change in sediment transport; direct or indirect habitat loss or change; red	Y **(Ref: expert judgement resons for identification as pHMWB in Article 5 Report)**	Reduce the need to dredge (e.g. Minimise under-keel clearance; fluid mud navigation; flow manipulation or training works)	1	Y	Y	-	-	-		
				Prepare a disposal strategy (e.g. Consider frequency and quantity of dredging; phasing; forward planning)	2	Y	Yes. Dump plan is up at the end of 2009. A new disposal strategy can be drawn up to keep in mind the impacts on the ecology and mitigation measures needed.	Yes	Yes	√		
				Reduce impact of dredging (e.g. Dredge smaller area, shallower depth; dredger type)	3	Y	Yes. Through the proposed development of Foynes more advanced structures will facilitate the reduced need to dredge within the HMWB. Modelling will also be carried out to ensure the structures are designed with the view to reducing the need to dredge.	Yes	Yes	√		
				Reduce sediment resuspension (e.g. Minimise bucket release; use visor; silt curtains; manage overspill)	4	Yes	Yes	Yes	Yes	√		
				Alter timing of disposal (e.g. Seasonal or tidal restrictions	5	Yes	Yes. Disposal is already restricted by the tide coupled with the fact that the dump site is outside the HMWB area	Yes	Yes	√		
				Sediment management (e.g. Trickle recharge, sediment bypass; water column recharge; beneficial replacement)	6	No. Investigations have previously been carried out on the dredged material which was deemed "not fit for use". Trailer suction is used which causes less impact	–	–	–	–		
				Indirect or offsite mitigation	7	No. As per comment at No. 6 there is no alternative use for the dredge material.	–	–	–	–		
Dredged material disposal	No	Smothering due to deposition of sediment; disturbance due to deposition of resuspended sediment; increased suspended sediment in water column; direct habitat loss or change due to disposal.		Site selection (e.g. Avoid sensitive sites)	8	–	–	–	–	–	–	–
				Manage disturbance (e.g. Confine disturbance; dispose over wider area; disposal method or rate)	9	–	–	–	–	–	–	–
				Prepare a disposal strategy (e.g. Consider frequency and quantity of dredging; phasing; forward planning)	2	–	–		–	–	–	–
				Alter timing of disposal (e.g. Seasonal or tidal restrictions)	5	–	–	–	–	–	–	–
				Indirect or offsite mitigation	7	–	–	–	–	–	–	–
Vessel Movement	Y	Physical disturbance of sea bed habitats; ship wash (leading to erosion); indirect impacts on habitats.		Modify channel (e.g. Deepen; realign channel)	10	Y	Y	-	-	-		
				Modify vessel design (e.g. Shallower draft)	11	Y	N	N	-	-		
				Vessel Management (e.g. Traffic management; speed limits)	12	No. In relation to 10, 11 & 12 there is currently no regular shipping schedule & SFPC have no control over it. Each ship/tanker which comes in the estuary and up the Shannon is piloted, best practise is implemented at all times and speed is kept within s	–	–	–	–		
				Indirect or offsite mitigation	7	No	–	–	–	–		
Existing modifications, including structures, reclamation and capital dredging	Y	Change in flows; changes in sediment transport; change in wave energy or direction change in water quality resulting from change in flows; direct or indirect habitat loss; disruption of habitat continuity or connectivity.		Remove obsolete structure	13	The development of the new master plan will take into account the removal of any obsolete structures.				√		
				Modify structure or reclamation (e.g. Construct culverts in breakwaters; reduce wave reflection; increase wave absorption; replace with environmentally friendly materials or design; compensatory dredging)	14	Yes. No waves are generated within the Foynes Island area and wakes are avoided by using tugs and the adherence to safety speeds. Many of these environmentally friendly materials/designs will be givn consideration in the overall plan.	Yes	Yes	Yes	√		
				Flow manipulation (e.g. Construct structures to normalise flow; realign frontage)	15	No.Works have historically taken place to nomalise the flow but the future development through the master plan will also address this and take it into consideration.	Yes	Yes	Yes	√		
				Sediment management (e.g. Trickle recharge, sediment bypass; water column recharge; beneficial replacement)	6	–	–	–	–	–		
				Indirect or offsite mitigation	7	–	–	–	–	–		

*Italics denote measures that are applicable to more than one impact.It may not be necessary to re-assess the measure, please see Guidance.

Hydromorphological assessment for classification	Good Ecological Potential or Better
CFB Fish Status	No Data
EPA Overall Draft Status	Good

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APPENDIX C

Consultation Correspondence

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From: Yvonne Nolan [Yvonne.Nolan@environ.ie]
Sent: 25 February 2011 14:35
To: Sheila Downes
Subject: our ref: G2011/64 - Shannon Foynes Port Company - Appropriate Assessment

Attachments: ATT1022678.txt

Dear Sheila,

I wish to confirm receipt of your correspondence and associated documentation on 22/02/2011. Your correspondence has been assigned reference no. G2011/64 and forwarded to the Development Applications Unit's professional advisers for comment and assessment on nature conservation grounds.

A response from this office will be issued to you on or before 5th April 2011.

If you have not received a response from this office by this date, please contact the undersigned quoting your assigned reference number (see above).

Yvonne Nolan,

Development Applications Unit,

Heritage Policy & Architectural Protection,

Department of the Environment, Heritage & Local Government,

Newtown Road,

Wexford.

Ph: (053) 9117382

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RPS

Notes

Project Title: SFPC Maintenance Dredging AA Report		Project Ref:IBE0215.00	File Ref: D
Date:03/03/2011	Time:14.30	Electronic Ref: R:\IBE0215 Foynes- Port\Reports\Maintenance Dredging AA Report.V0\Consultation Responses	

☐ Discussion ☐ Meeting ☐ Site Visit ☒ Telephone ☐ Task Briefing ☐ File Note

Meeting/Visit Location:

Subject: SFPC Maintenance Dredging AA Report to accompany Dumping at Sea Application

Between those present
Sheila Downes & Jervis Good

Item	Notes	Action	Due Date
1	Letter passed from the DAU to Jervis Good Divisional Ecologist		
2	Preliminary comments which should be addressed in AA Report as outlined by Jervis Good		
	○ In combination effects of dredging with other dredging operations in the Shannon Estuary	RPS	
	○ There should be no loss of sediment downstream	RPS	
	○ Has a sediment budget been undertaken	RPS	
	○ Need to demonstrate no loss of mudflats/no changed in mapped areas from continuous dredging operations over the past number of years.	RPS	
	○ Need to demonstrate that there will be no contamination from sediments through RPII results and analysis based on Marine Institute parameters	RPS	
	○ NPWS will review the AA once submitted through the EPA as part of the dump at sea application	NPWS	
	○ Take account of new guidance related to ports and the in-combinations effect in it,	RPS	

Distribution:			✓				
Signed:				Dated:			

Continued overleaf

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