Lerwick Port Authority – Lerwick Harbour & Dales Voe Dredging

Drill & Blast Dredging

Trial Blast – Proposed Underwater Acoustic Monitoring Method Statement

Arch Henderson
a company of Haskoning

Stewart Building
Esplanade, Lerwick
Shetland, ZE1 0SE
Tel: 01595 695512
www.arch-henderson.co.uk
lerwick@arch-henderson.co.uk

LERWICK PORT AUTHORITY

Lerwick Port Authority
Albert Building
Lerwick
Shetland, ZE1 0LL
Tel: 01595 692 991
info@lerwick-harbour.co.uk

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1.0 Introduction

Under current Marine Licenses (MS-00011195 & MS-00011213), Lerwick Port Authority have MD-LOT consent to undertake dredging using Trailer Suction Dredging (TSD) and Back-Hoe Dredging (BHD) techniques. These works are currently ongoing.

As part of the dredge campaign then there is a requirement to carry out a proportion of drill and blast (D&B) dredging to remove the final depth of hard rock in isolated areas of the project. In this respect then additional / amended marine applications were submitted to MD-LOT on the 1st August 2025 together with updated Habitats Regulation Appraisals (HRAs) and accompanying European Protected Species (EPS) licence applications and associated Marine Mammal Risk Assessments (MMRAs).

2.0 Dredging Progress

As an update on the current live dredging campaign, Boskalis Westminster Ltd (BWL) have had some great success in dredging with their back-hoe dredger (BHD) *Magnor*, removing approx. 60% of Lerwick Harbour & 20% of Dales Voe predicted hard rock mass model. In practical terms then this potentially equates to a reduced drill and blast campaign from previously predicted 7.5 to 5.0 weeks in Lerwick Harbour and from 3.5 to 2.5 weeks in Dales Voe.

BWL completed Phase 2A BHD dredging works in Lerwick Harbour and Dales Voe on 8th October 2025 with following progress:

Lerwick Pre-survey paid volume above design = 354,455m3. Interim survey volume above design = 54,706m3. Total Lerwick dredge contract complete to date = **84.56%**

Dales Voe Pre-survey paid volume above design = 78,097m3. Interim survey volume above design = 31,809m3. Total Dales Voe dredge contract complete to date= **59.27%**

Current dredging campaign now awaiting Marine Directorate / NatureScot assessment of the required final drill and blast (D&B) dredging campaign to complete dredging down to design levels using agreed methods and mitigation.

Mobilising of D&B plant / Smaller BHD is now required to complete the final remaining dredging to required depths.

Attached in Appendix A are plans showing original and now revised extent of rock dredging that still requires to be removed by the D&B campaigns at both Dales Voe and Lerwick Harbour. Figure 1: Dales Voe shows prediction of Maximum Instantaneous Charge (MIC)/average Qmax at two distinct locations, Figure 2 shows MIC/Qmax in north Lerwick

Harbour and Figure 3 shows MIC / Qmax at Lerwick Harbour North Ness area. Explanation of charge values shown are described later in this report

3.0 Programme

In terms of the current live contract programme then the final D&B campaign mobilisation was required in mid-October with final D&B dredging works commencing on 11th November 2025, but this date has now passed and anticipated commencement now in Spring 2026, subject to receiving required consents.

4.0 Method Statement – Drill & Blast Dredging – Trial Blast Underwater Acoustic Monitoring

The key objective is to remove the final depth of hard rock strata that has not been possible to remove using current BHD to date. The dredging contractor has updated the rock model showing areas where D&B is required at each site. Within each blast field, a number of boreholes are drilled down to depths varying between 2m and 8m. The blasting engineers determine the numbers of charge weights and the size of each charge weight such that the resulting detonation successfully fractures the overburden over the entire blast field. Straight after blasting then BHD technique removes material down to required final dredge depth with all material removed taken to the licensed offshore disposal area.

Drilling and Blasting

Rock that cannot be directly dredged using backhoe or trailer dredger, either because of rock strength or low fracture rate will require pre-treatment using drill and blast methodologies. The drilling and charging will continue on a 24 hours a day, 7 day a week basis.

Drilling and blasting will occur from a specialist drill platform 'Rockmate' equipped with two marine drill tower units. The 'Rockmate' is 41m x 18m and utilises four spud legs (avoiding the requirement for anchor spread).

Drilling

For each area a test-blast location will be determined in a less sensitive area to gather information on vibration and underwater noise impact. Drilling will start at the minimum rock layer depth meaning explosive placed into the hole can be reduced, so the MIC (Maximum Instantaneous Charge) will also be small.

The drill pattern will vary between the areas based on design thickness, rock strength and locality to structures. The space between drill points will vary from 2.0m-5.0m, covering approximate $4m^2$ to $20m^2$ for each drill point. The drill pattern will be adjusted as required. Drilling will extend up to 2m below design to ensure the later dredging can fully remove the

rock to the required design level and to reduce the number of pinnacles created during the blasting operation. Drill holes can vary in diameter from 85mm to 165mm.

To ensure that the blasting extends over the full dredge area it will be necessary to drill up to 1-2m beyond the planned extents of the dredge area.

Blasting

Offshore Kemiitti Explosives, a liquid explosive, with packaged boosters and detonators will be used for the works. These explosives are specifically tailored to be used in underwater rock blasting. In addition, provision for EXEM 100 50mm diameter packaged emulsion provided by EPC for required controlled works to manage MIC (Maximum Instantaneous Charge Weights) and thus controlling vibration as required.

Trial blasting is required to ascertain the site parameters for vibration predictions. Initial trial blasting will be carried out as part of the production, but with charged levels reduced to ensure vibration levels at nearby structures stay below the normal operational safe limits. Several trail blasts over the first days will be used to take these trial measurements.

A blast warning procedure will also be implemented.

A warning signal (both aural and visual) will be emitted several minutes before the blast and the area checked visually for the presence of swimmers, divers, vessels, mammals, etc. in good time.

A typical example of a blast warning procedure is:
• The local VTS and other specified parties will be informed 60 minutes prior planned blasting.
• Ten minutes before blasting: - Relevant parties will be informed by radio and / or phone.
• A blasting control vessel equipped with red flag will depart the 'Rockmate' to patrol designated safety area. An additional fast craft vessel will be available to encourage species out of the MMO area, if required. ADD will also be available on site but will only be used if persistent issues arise with species converging into or not leaving MMO area just prior to a blast.
• VTS will be contacted to obtain all clear to blast (vessel traffic, divers etc.)
• The supervisor onboard will make visual check of the area and obtain confirmation from blasting control vessel that everything is correct.
• Upon receipt of clearance short sound signals will be given and the blast will be initiated after the last signal.
• After successful blasting one long sound signal will be given and relevant parties will be informed on the radio that blasting is completed.

The use of bubble curtains has currently been discounted due to the wide-open site and existing heavy vessel traffic.

The quantity of explosives in each hole will be dependent on the layer of rock. However, it has been estimated that it would range from approximately 20kg to 130kg per hole resulting in a maximum MIC of 110kg per blast at Dales Voe and 130kg per blast at Lerwick Harbour. It is also estimated that 9-90 holes will be drilled in for each field.

Therefore, it is estimated[1] that as a worst-case scenario, the charge size used for blasting is expected to be approximate 0.7kg explosives / m3 rock.

Charges will go off at the beginning and end of each day (daylight). This would equate to approximately 400kg – 1,250kg per 12 hrs shift.

As part of an overall mitigation of blast noise impact intensity then the contractor is proposing to use 25 millisecond blast delays between each charged hole to help minimise the MIC / Qmax value for each overall blast. A sample blast design calculation is appended. It shows a drill pattern with a typical overall total charge weight of 980kg over 30 holes, but with blast delays resulting in an MIC/ Qmax value of 70kg. This individual blast hole charge delay method was previously used at Lerwick Harbour dredge campaign in 2008 and during Holmsgarth Pier Development in 2018.

Blasting is expected to occur over a duration of 2.5 weeks at Dales Voe and 3.5 to 5 weeks at Lerwick Harbour, weather depending, and may be undertaken partly in winter.

Vessel Movements Associated with Works

Dredging

The dredging works will include associated vessel movements with dredging itself and then barges moving between the dredge site and the disposal site.

It is anticipated there will be approx. maximum 4 to 5 barge transit per 24 hours throughout the overall the final D&B / dredging period. Therefore, total vessel movements in Dales Voe to complete dredging is approx. 30 to 45No. barge transits over 2.5 weeks depending on final over dredge quantities and in Lerwick approx. 55 to 70No. barge transits over 5 weeks.

The vessel route to current designated dump site for Lerwick and Dales Voe is approximately 3.5km and 4.5km long respectively.

[1] Contractors have advised that it is hard to estimate the total amount of explosives required per field as this is dependent on a variety of factors, including substrate type etc.

Based on the above then the present HRA assessment has a Marine Mammal Observation mitigation zone of 1km for blasting (from JNCC guidance) and 500m for dredging.

Impulsive Noise Data Collection

In order to record impulsive noise in the field and assess relative to above MMO mitigation zones then the following method is proposed to be undertaken by a specialist underwater acoustic noise contractor during a programme of trial blasts leading onto the main D&B campaign to have confidence that suitable and practical MMO distance is used.

In order to monitor underwater noise levels during blasting, measurements of blast noise will be recorded simultaneously at locations of 500m and 1000m from the trial blast centre in a direction north of blast. The trial test blast locations will be determined in less sensitive area to gather information on vibration and underwater noise impact. Figures 1 to 3 show locations at Dales Voe and Lerwick Harbour. The proposed trial blast method is to restrict initial MIC to 20kg with incremental trial increases (2-5kg) up to an agreed maximum MIC that maintains underwater noise impact thresholds below disturbance levels for marine mammals at agreed MMO distance. The objective is to ensure that all recording stations lay along a direct line-of-sight transect commencing at the blast field. These trials will be conducted at location shown (Figure 1 – south area Dales Voe, Figure 2 Greenhead and Figure 3 North Ness Channel).

The survey line along which the measurements will be made is indicated on attached plans. These would include included an underwater noise monitoring points at 500m radius and 1000m radius.

Two boats will be used during the D&B trials with hydrophones capable of detecting marine mammals.

If at any time during the D&B dredging works, there are issues with marine mammals converging inside the agreed MMO distance then an Acoustic Deterrent Device (ADD) will be available on site and deployed on the above boats to encourage marine mammals to leave the area ahead of the blast. The ADD is essentially a transducer on the end of a 50m cable connected to a topside unit with only a single switch to turn the device on or off. A back up spare device will be deployed on each boat.

Blasting will not take place when the weather and sea state effects efficiency of the MMO and mitigation measures.

Prior to each blasting schedule, a specialist noise survey team will liaise with the Boskalis Westminster Ltd blasting engineers to ensure that two survey vessels are on the 500m and 1km lines in good time. Noise data, that is collected at each recording station over durations

ranging from a few minutes to 1 hour or more will be recorded to provide general background noise, which can be calibrated and used in the data acquisition system so as to provide a standardised noise level against which all subsequent measurements would be compared; and the blast noise itself.

In addition to the noise data, the specialist noise survey team will also collate log sheets indicating which blast field was being drilled; the numbers of boreholes prepared the numbers of charges that were successfully detonated; state of weather and tide; and any other sources of noise that were present in the area from time to time. All data will then be made available for subsequent data processing and analysis.

Impulsive Noise Data Analysis

The noise data will be supplied as voltage-time series in one or more .WAV files. Subsequently, a calibration adjustment factor related to the ratio of the output signal amplitude to the input signal amplitude will be applied to the blast wave data.

The blast data will then be converted into a pressure-time series after taking into account the hydrophone frequency sensitivity; the terminal unit gain settings; and calibration factor.
The maximum amplitude of each blast event is then transcribed to give the peak blast level at each station distance. The rms value is then ascertained over each time duration.
From the positional data contained within both Boskalis Westminster Field Contractor's Log and the special monitoring contractors log, the distance between the blast site and each recording station is determined.

Summaries of the peak and rms noise levels at each station are then established.

Results will then be shared with MD-LOT and NatureScot with recommendation on final practical MMO distances and impulsive noise limits for marine mammals to avoid temporary and permanent noise-induced threshold shifts; TTS and PTS.

Appendix A – Current Predicted Rock Dredging Areas Requiring Drill & Blast / Estimated MIC/Qmax charges and location

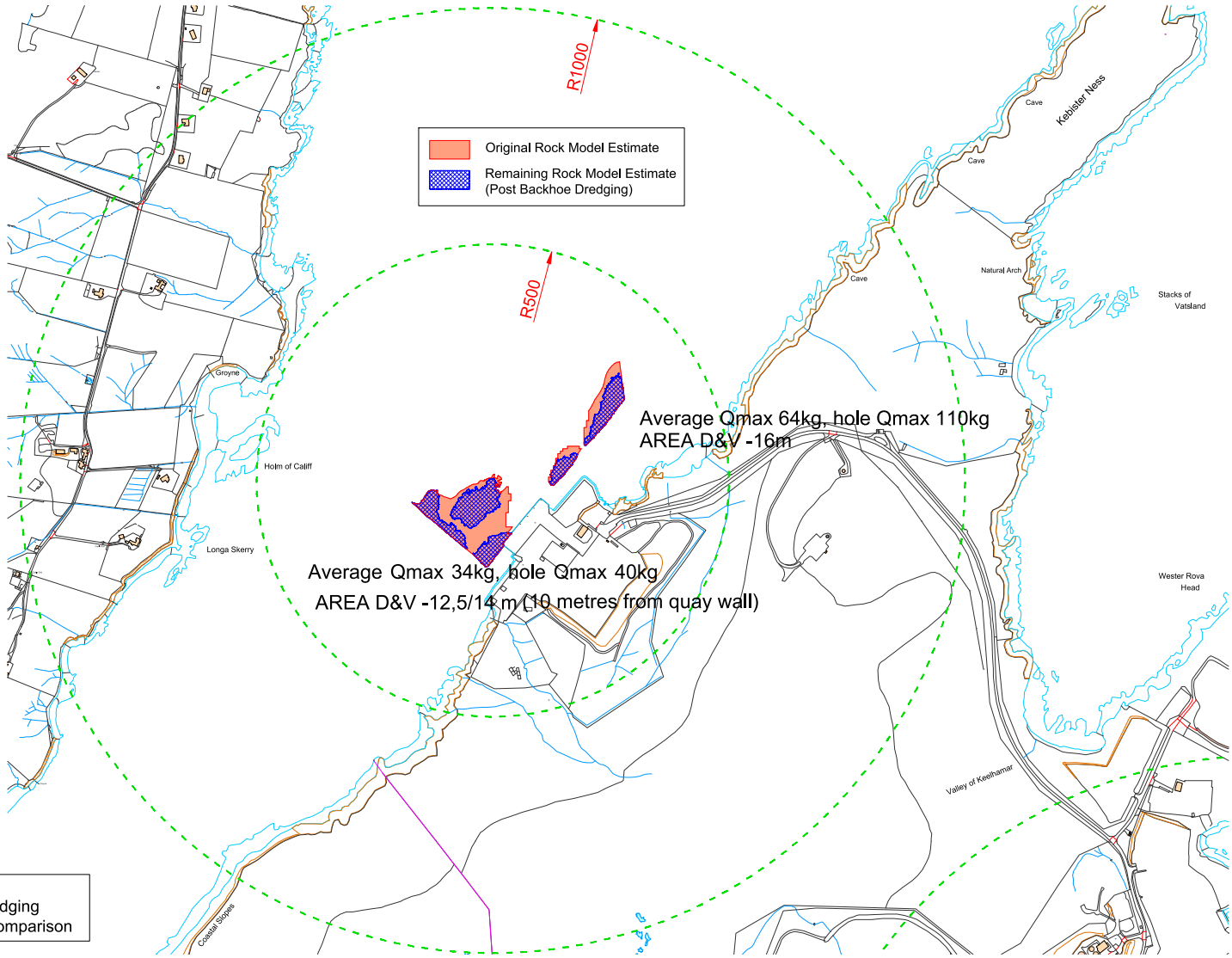

Figure 1:
Dales Voe Dredging
Rock Model Comparison

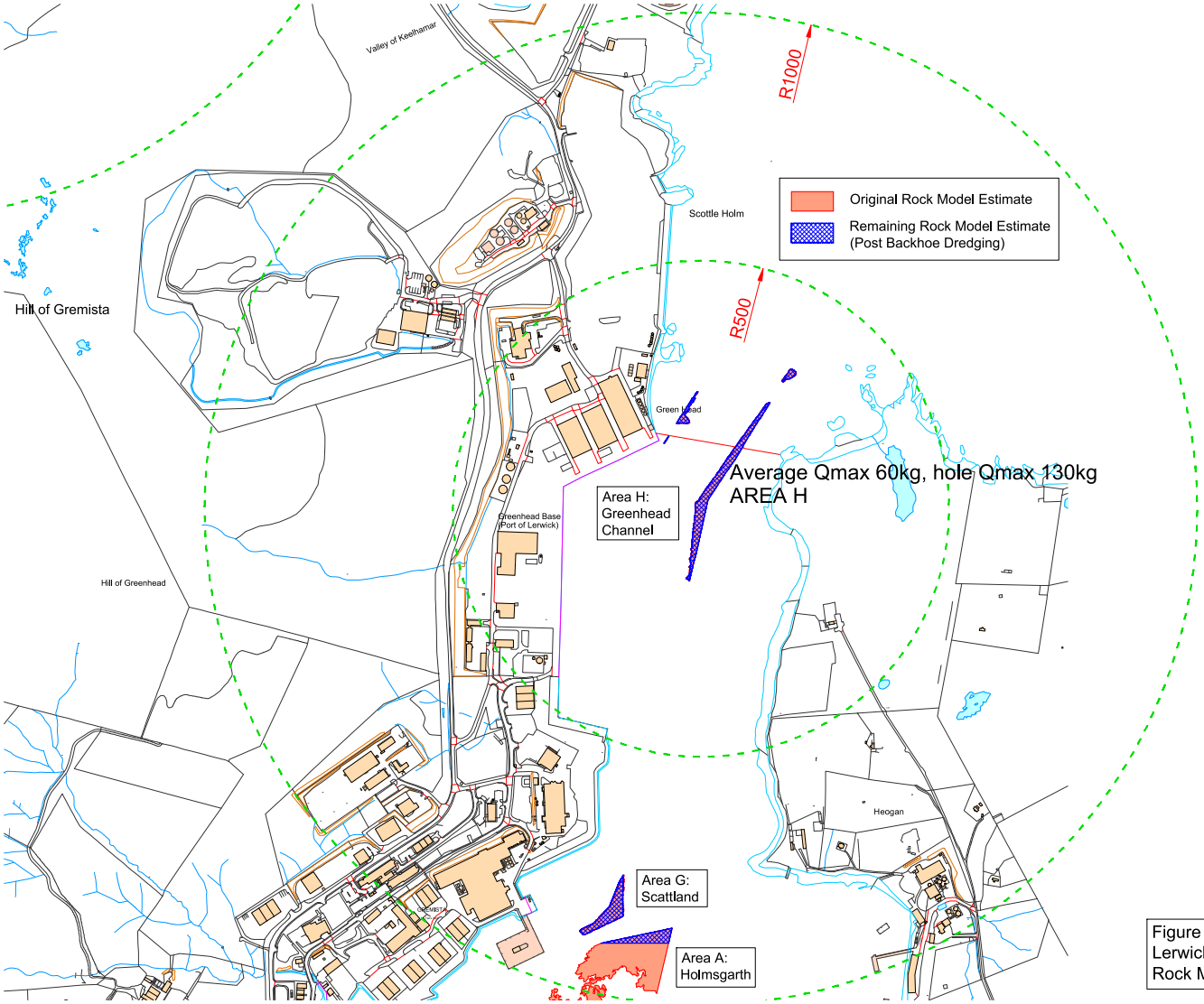

Figure 2:
Lerwick Harbour Dredging - North
Rock Model Comparison

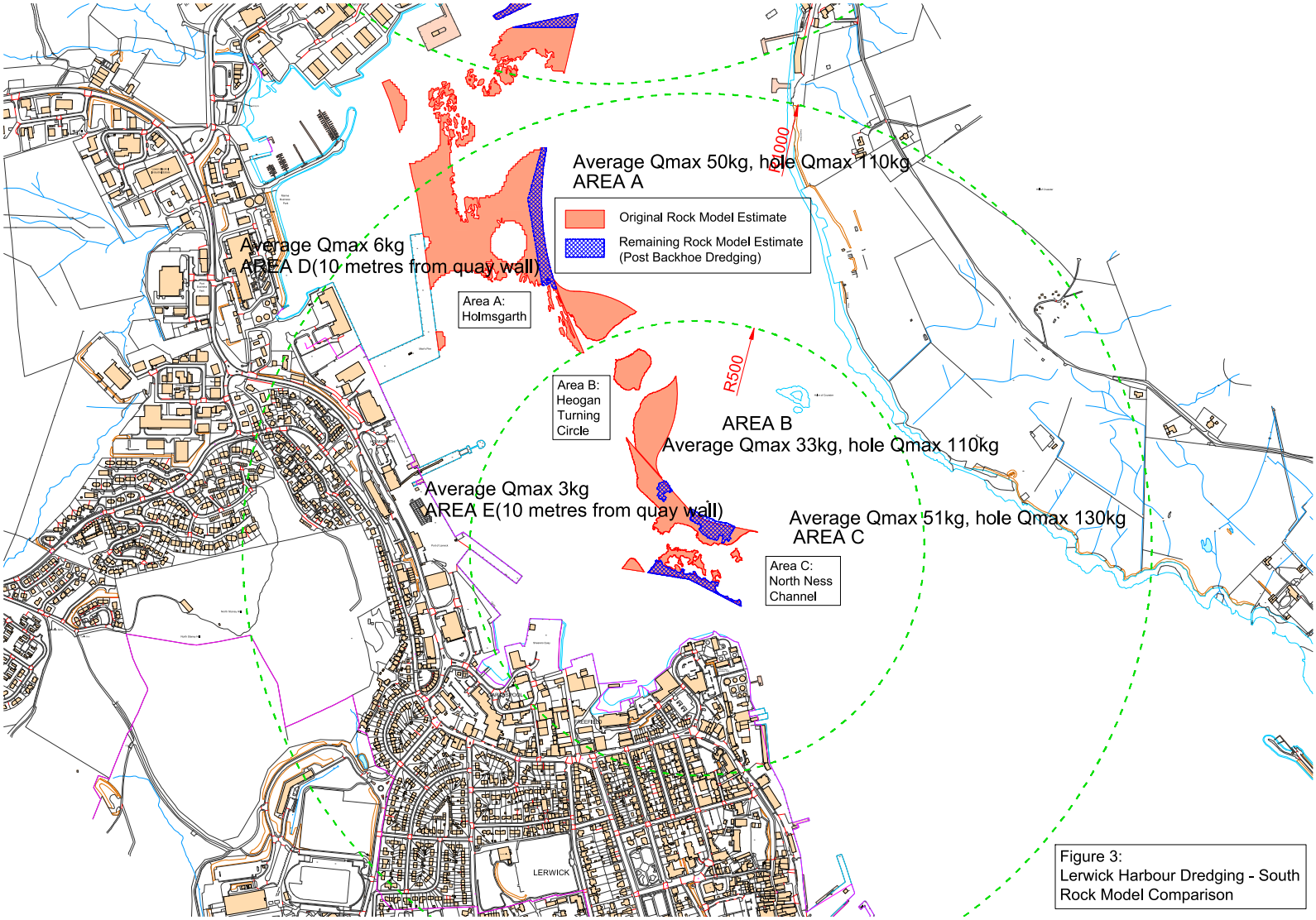

Figure 3:
Lerwick Harbour Dredging - South
Rock Model Comparison

Example Blast Pattern

Section 102.5

In-Hole Delay **500** **msec**

Start

			1	2	3	4	5	6		
			Free Face							
	kg/hole		20	34	32	25	45	50		206
			525	550	600	675	775	900	Lower primer	
			25	50	100	175	275	400	Surface timing	
Row	1		1	2	4	7	11	16	Hole No	
	kg/hole		26	28	50	34	25	35		198
			575	625	700	800	925	1025	Lower primer	
			75	125	200	300	425	525	Surface timing	
Row	2		3	5	8	12	17	21	Hole No	
	kg/hole		15	18	29	70	30	65		227
			650	725	825	950	1050	1125	Lower primer	
			150	225	325	450	550	625	Surface timing	
Row	3		6	9	13	18	22	25	Hole No	
	kg/hole		18	20	34	30	25	32		159
			750	850	975	1075	1150	1200	Lower primer	
			250	350	475	575	650	700	Surface timing	
Row	4		10	14	19	23	26	28	Hole No	
	kg/hole		10	16	32	45	45	42		190
			875	1000	1100	1175	1225	1250	Lower primer	
			375	500	600	675	725	750	Surface timing	
Row	5		15	20	24	27	29	30	Hole No	

Free Face

Total kg/Blast	**980**	**kg**
MIC	**70**	**kg**