BERWICK BANK WIND FARM
OFFSHORE ENVIRONMENTAL IMPACT ASSESSMENT

APPENDIX 10.1, ANNEX C: PROPAGATION LOSS MODEL CALIBRATION AND COMPARISON

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Prepared by:	**RPS**
Prepared for:	**SSE Renewables**
Checked by:	**Douglas Watson**
Accepted by:	**Kerr Mackinnon**
Approved by:	**Ross Hodson**

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FIGURES

1. MODEL CALIBRATION

1. To compare the output of the Weston Energy flux model developed for acoustic propagation analysis, two test cases were carried out estimating the transmission loss of acoustic energy in a chosen ocean environment run on different modelling algorithms. The methodology for calibration and the results of these tests are given in the following paragraphs.

2. For comparison the different propagation models used were: Weston, ACTuP based parabolic equation solver RAMGeo, a simple 20 $\log_{10}$(R) fit, and the Roger's model. This report discusses the outputs of different underwater acoustic propagation models that have been applied in the Proposed Development subsea noise study area, and the subsea noise frequencies of interest. The aim is to compare the estimated broadband sound exposure levels (SELs) with distance from a pile, and to evaluate the suitability of each underwater acoustic propagation model.

3. Each acoustic model was evaluated on one transect (2D ocean) within the survey region. The environmental, seafloor, bathymetry, and frequency inputs were kept consistent. These were:
   - Speed of sound in seawater: 1,485 m/s;
   - Speed of sound of geological top layer: 1517 m/s;
   - Density of seawater: 1,024 kg/m^3;
   - Density of the top geological layer: 1860 kg/m^3;
   - Water temperature: 8°C;
   - Source depth: 20 m; and
   - The frequencies of simulation were 1/3rd octave centre bands from 20 Hz to 1 kHz.

4. To compare the output of the Weston Energy flux model developed for acoustic propagation analysis, the Transmission Loss (TL) results from the following propagation models were employed:
   - ACTuP based Parabolic Equation solver (RAMGeo);
   - ACTuP based Normal Mode solver (KrakenC);
   - Rogers (1981) semi-empirical model; and
   - a simple 20 $\log_{10}$(R) fit.

5. The third octave band TL output of each model was combined with the relevant banded Source Level (SL) of piling noise source (with a broadband SEL set at 217 dB re 1 µPa^{2}s). The individual Received Level (RL) frequency third-octave banded results for each of these models were plotted against distance (m) and then combined into broadband RL and this result is illustrated in Figure A9.1.

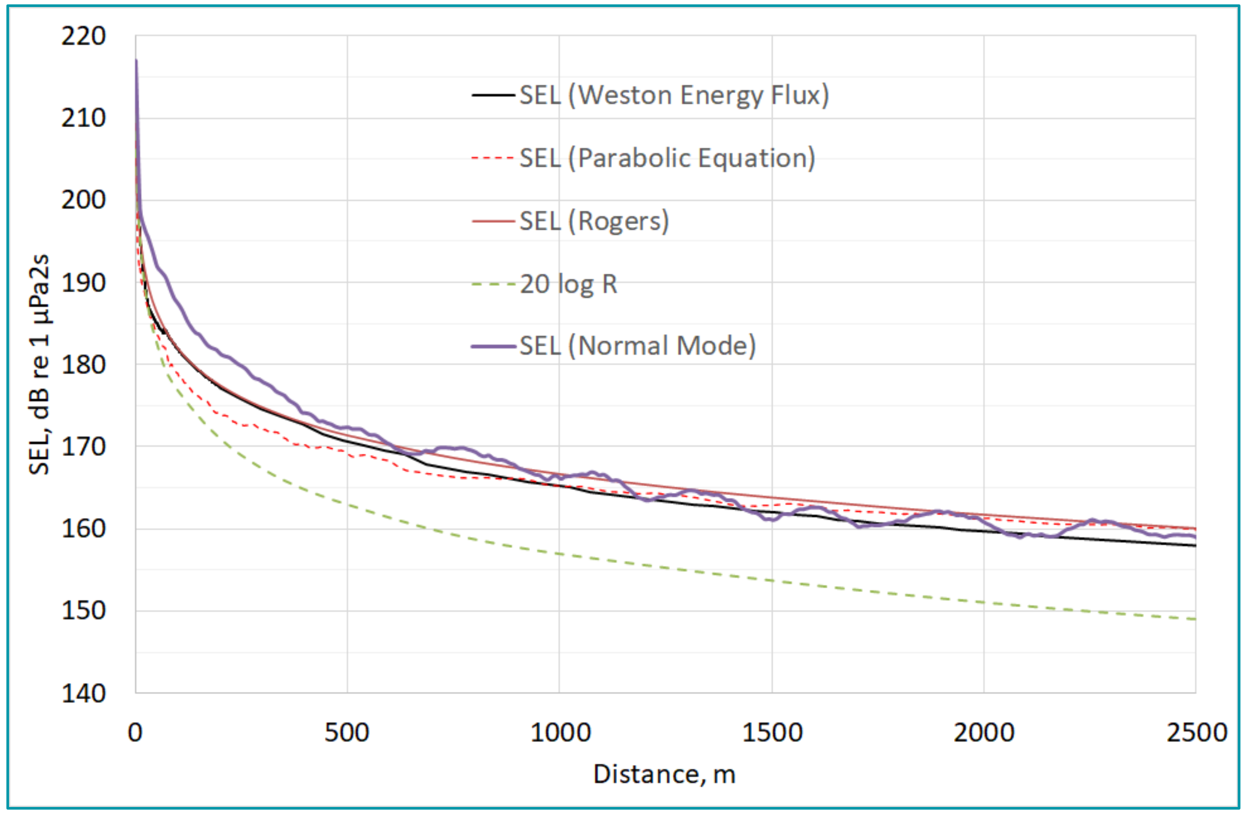

Figure A9.1: Comparison of Seiche's Weston Energy Flux Model with Other Acoustic Propagation Modelling, Assessed over a Variation of Broadband SEL vs Distance

6. The results of the modelling show good correlation between the Weston, ACTuP RAMGeo and Roger's model with typically 1 dB or less difference between the models. The Parabolic Equation model results in lower levels closer to the pile, at ranges of less than 1 km, whereas the Weston model produces lower results at larger ranges. The Normal Mode model also falls within the expected results at ranges beyond 500 m (with a little more variability), but results in slightly higher SEL levels at distances of less than 500 m.

7. The lower limit of the 20 log R model in the figure, reports the lowest expected RL or the highest expected TL in the Proposed Development subsea noise study area.

8. On balance, it is considered that the Weston Energy Flux model used for assessment in this report produces similar results to other well established ocean acoustic propagation models and can therefore be assumed to be a robust and suitable methodology.

2. REFERENCES

Rogers, P. H. (1981). *Onboard prediction of propagation loss in shallow water*. Naval Research Lab Washington DC.

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