Alexandra Basin Redevelopment 2

Bringing Dublin Port To 2040

Environmental Impact Assessment Report

Appendix 13-2 Weston Propagation Model Validation

Volume 3



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TETRA TECH

APPENDIX 13-2 – WESTON PROPAGATION MODEL VALIDATION

The Weston 1971-1976 sound propagation model was first published in 1971 as “Intensity-Range Relations in Oceanographic Acoustics” by D. E. Weston in the Journal of Sound and Vibration, with an update in 1976 as “Propagation in Water With Uniform Sound Velocity but Variable-Depth Lossy Bottom” by D.E. Weston in the Journal of Sound and Vibration.

The model presents a pragmatic approach to sound propagation modelling by splitting propagation into four distinct regions dependent on the given range, water depth and wavelength, and has be made range-dependent for both depth, soundspeed and sediment properties.

This appendix presents a few testcases with known solutions compared to this implementation of the Weston propagation model.

Comparison to normal modes, ray-tracing and parabolic equation models

Source:

Sertlek H. Ö. & Ainslie M. A (2003), “Propagation loss model comparisons on selected scenarios from the Weston memorial workshop”. 1st International Conference and Exhibition on Underwater Acoustics.

Case 1

Depth 100 m, max range 40 km.

This is a simple semi-deep waveguide which might be considered representative for parts of the continental shelf.

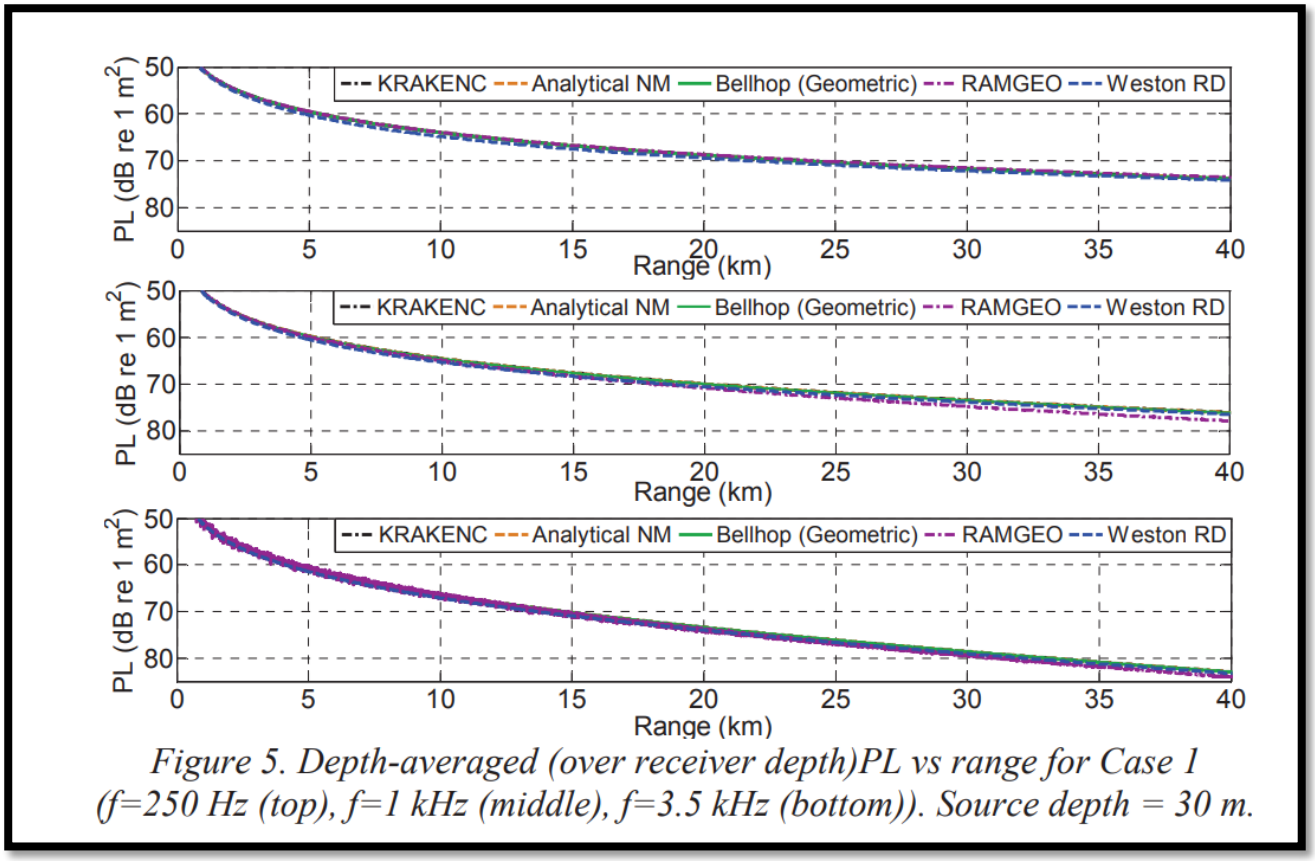


Figure 5. Depth-averaged (over receiver depth)PL vs range for Case 1 (f=250 Hz (top), f=1 kHz (middle), f=3.5 kHz (bottom)). Source depth = 30 m.

Case 2

Depth 100 m to 5 km then sloping up to 30 m at 7 km. Remaining at 30 m depth to 40 km range.

The step up at 5 km range tests the models' ability to calculate the effect of slowly changing depths in an upslope environment. Note that for 250 Hz (top panel in figure below) the Weston model underestimates the loss after c. 20 km, leading to a higher received level. The ray-tracer (Bellhop) shows the same result. This is expected as the Weston model relies on approximations made from ray-theory to specify the transitions between propagation regions.

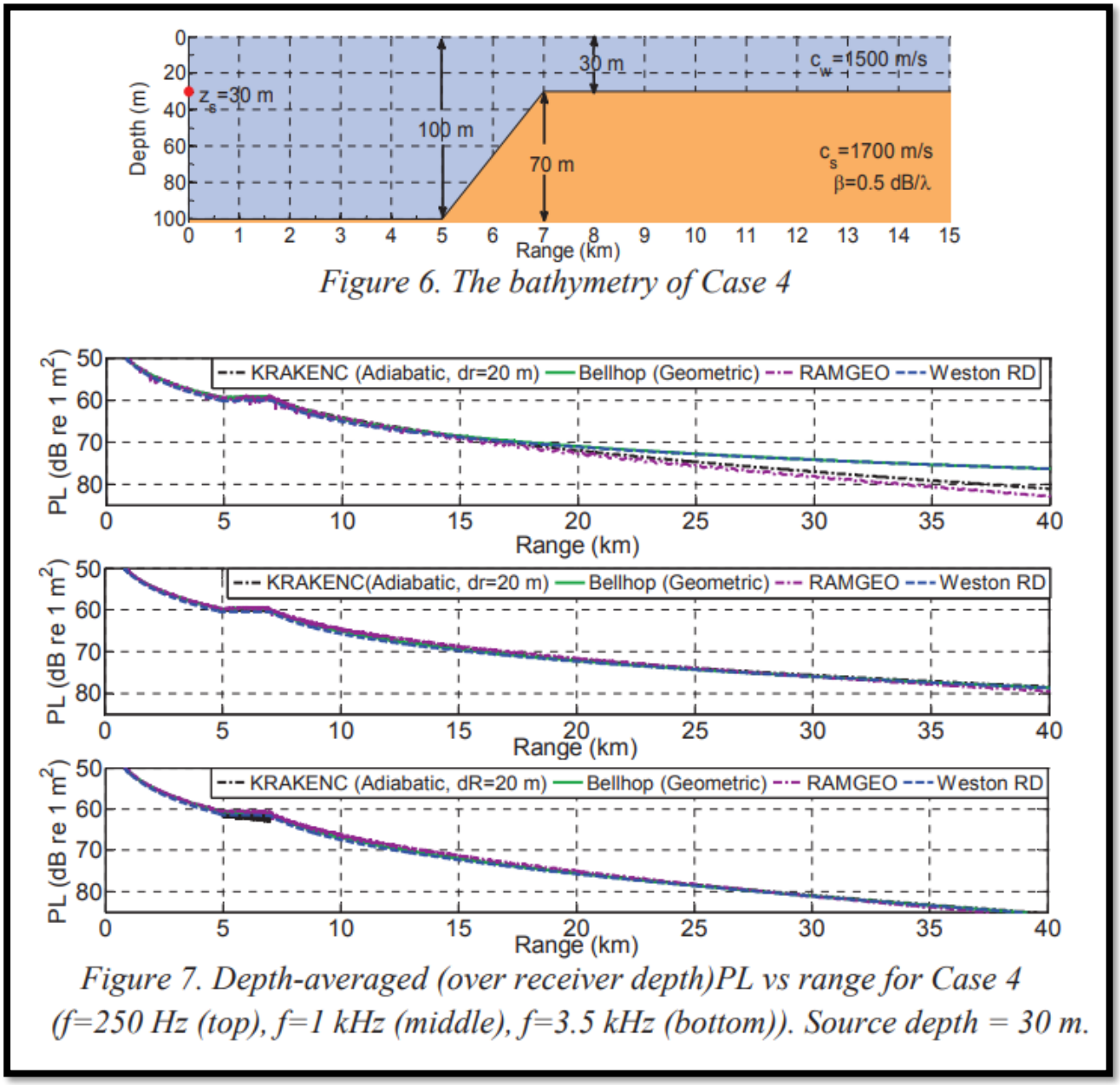


Figure 6. The bathymetry of Case 4

Figure 7. Depth-averaged (over receiver depth)PL vs range for Case 4 (f=250 Hz (top), f=1 kHz (middle), f=3.5 kHz (bottom)). Source depth = 30 m.

Case 3

Depth 100 m to 5 km, then sloping up to 30 m at 7 km. Remaining at 30 m depth to 7 km, then sloping down to 100 m depth at 10 km.

The “bump” scenario represents a shallow bank between two deeper sections. It tests the models’ ability to transition between different regions of propagation. There is excellent agreement between the Weston model and the numerical models.

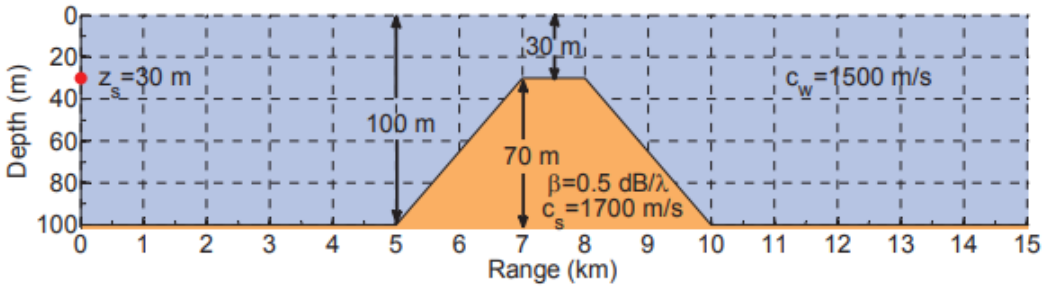


Figure 8. The bathymetry of Case 9

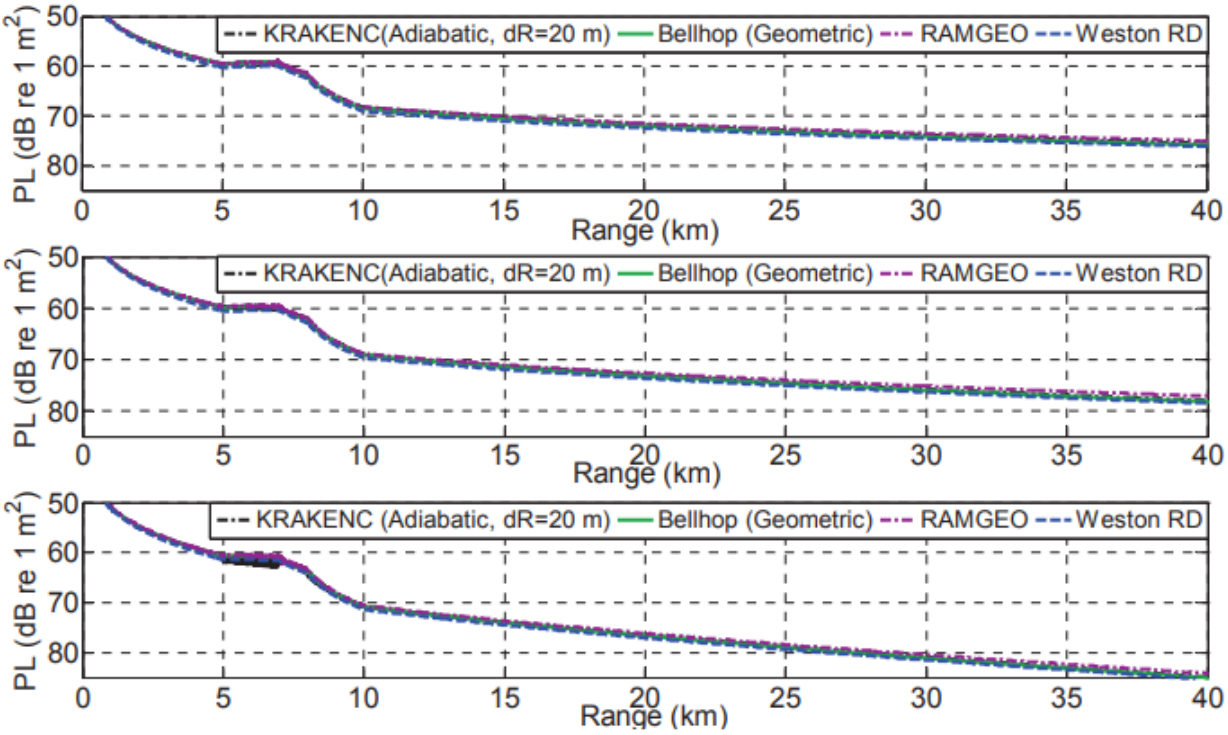


Figure 9. Depth-averaged (over receiver depth) PL vs range for Case9 (f=250 Hz (top), f=1 kHz (middle), f=3.5 kHz (bottom)). Source depth = 30 m.

Broadband comparison with various commercial models

Source:

Bas Binnerts, Christ de Jong, Ilkka Karasalo, Martin Östberg, Thomas Folegot, Dominique Clorennec, Michael A. Ainslie, Graham Warner, Lian Wang (2109), "Model Benchmarking Results For Ship Noise In Shallow Water", JOMOPANS.

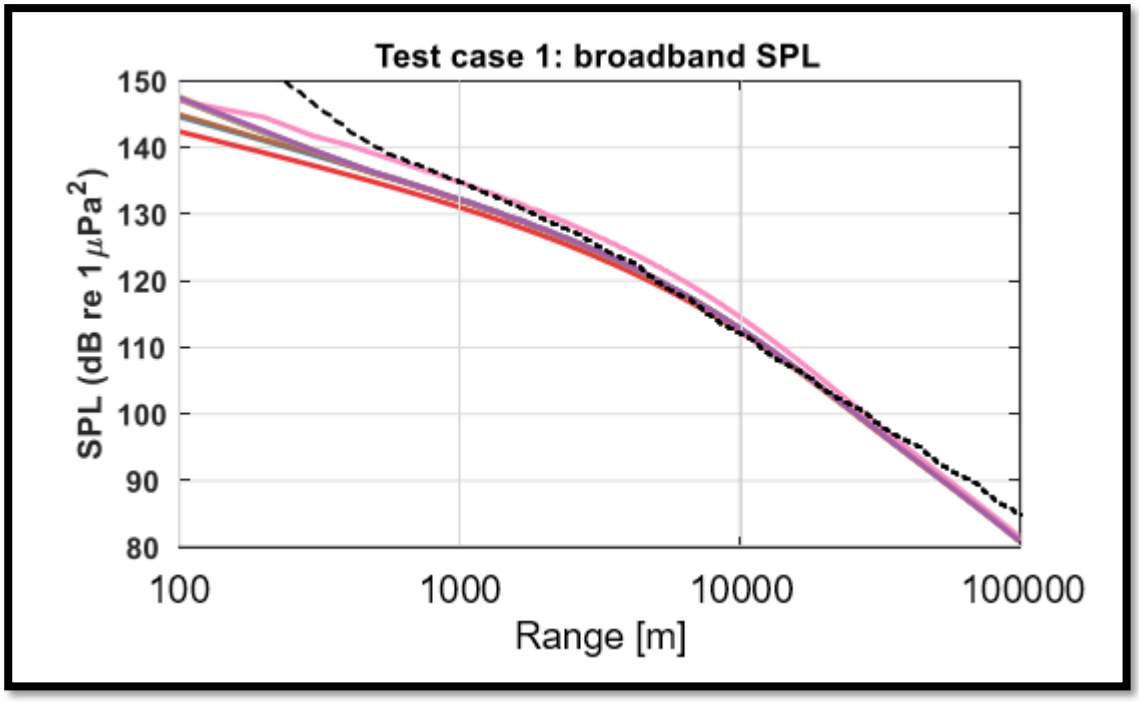
Two cases are investigated, both with a vessel source model used as the source and from 10 Hz to 20 kHz.

Case 1

50 m depth to 100 km range.

Broadband levels versus range

The Weston model (black dashed line) matches the general losses well at ranges over c. 500 m.



Case 2

100 m depth to 5 km, then upslope to 30 m depth at 7 km. Remaining at 30 m depth to 50 km range.

Broadband levels versus range

The Weston model (black dashed line) matches the general losses well at ranges over c. 500 m.

